HORTICULTURE BY IRRIGATION

A. E. GIPSON

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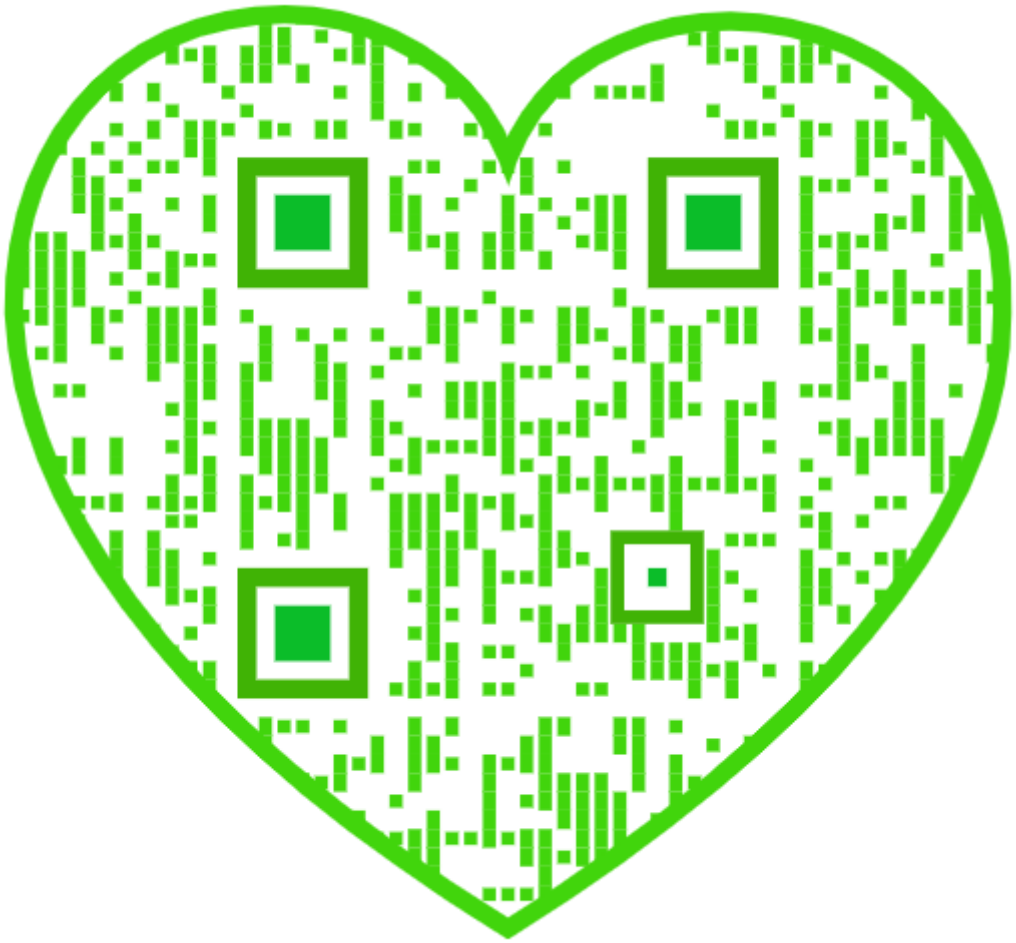

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HORTICULTURE

BY

IRRIGATION;

BY

A. E. GIPSON,

PRESIDENT OF THE COLORADO STATE HORTICULTURAL AND FORESTRY ASSOCIATION, AUTHOR OF "WHEN AND HOW TO IRRIGATE," ETC.

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PREFACE.

It is scarcely necessary to remark that this volume is not, in any sense, intended to be exhaustive, nor to take the place of other excellent publications that treat the subject of horticulture in detail. The aim has rather been to find out the best methods of orchard and garden culture under irrigation, so far at least as Colorado experience has gone; to give practical rules so far as possible for the application of water to trees and plants, and to furnish a list of the leading varieties best adapted to this portion of the Rocky Mountain region.

The numerous applications to the author in the past few years for a practical handbook on the subject in question, with more especial reference to the needs of this portion of our country, has prompted the publication of this little book.

That Colorado and adjoining territory, particularly on the South and West, are destined to become large producers of the horticultural staples, there seems little doubt. The wide diversity of soil, climate and variations of altitude, the dryness of air and almost perpetual sunshine from the skies, together with reasonable assurance of an ample water supply, all combine to make success possible in many directions. Hence, there is scope and hope for much that must necessarily be denied to other portions of our land, that do not possess these natural advantages and distinctive conditions.

While this is true, it should be remembered that we have scarcely more than entered the experimental period in horticultural development. The effect of altitude and constant sunshine on fruit stock, the influence of irrigation on soils as well as fruits, the "duty" of water, the best means of guarding against early and late frosts, and from the rapid transitions in some districts from zero weather to the temperature of Spring; these

and other complicated problems in pomology, must be encountered. For these reasons it should not be surprising if the history of fruit growing in much of the West and Northwest repeats itself here, in a measure. That the same faith, perseverance and intrepidity, which led men to invade these Great Plains and subdue them, that prompted the pioneers in horticulture of a quarter of a century ago to transport the first plantings a thousand miles by ox and mule teams to the New West, and that has led others in more recent times to make great sacrifices in the same direction—that indomitable energy and persistence will triumph, there is little room for doubt. Let us be patient therefore and strive for the best possible results in the work before us. In the preparation of this volume I have been aided not only by those who have kindly contributed to its pages, but by suggestions from leading horticulturists of different parts of this State, to each and all of whom I desire to tender thanks. Especially do I acknowledge indebtedness for favors shown, to Professor James Cassidy, instructor in botany and horticulture at the Colorado State Agricultural College.

A. E. G.

Greeley Nurseries and Gardenside
Fruit Farm,
Greeley, Colo., February, 1888.

A BRIEF RETROSPECT.

The marvelous development of the Great West has no parallel in the history of the world. Little more than a quarter of a century ago fully half of our continent was comparatively unknown and was associated with all that was to be dreaded in the most dismal features of desert life. A vast region of country stretching through twenty degrees of longitude and as many of latitude, with a mighty mountain range as its backbone, was, less than fifty years ago, supposed to be a barren and uninhabitable waste. The bugbear in an overland trip to the Pacific Slope was the crossing of the "Treeless Sand Plains" that interposed their parched and cheerless expanses for nearly a thousand miles. Even the wisest statesmen of that time saw in all this an insurmountable obstacle to the building of a line of continental railway.

The gallant Fremont, who came this way at an early day, reported officially, "that all west of the Missouri River was barren desert, unproductive, rainless and treeless."

Many of to-day, not far advanced in years, can recall the wild, wierd pictures of the "wind swept solitude," of a sand storm on the "Great American Desert," and perhaps of the complete destruction of some luckless caravan. To my own mind as these lines are written, come vividly the sketches of the awful doom that often overtook those who ventured too far beyond the borders of civilization. Poisonous simoons were written about, and the picture was not complete without reference to those who had been lured to destruction by the cruel deception of the fatal mirage. The hero of those days was he who had penetrated this strange land and had been permitted to return safely to the "Father of Waters." Now as one is hurried by the iron horse over any one of the half-dozen great railways that span this same wonderful country, what a transformation is opened to view. Instead of the grim and hideous visions of boyhood days, the desert has blossomed and a land is seen rich in verdure, dotted with cities, villages and beautiful homes and teeming with the evidences of a vigorous civilization. Within little more than a score of years the practical men in horticulture have made glad the waste places

by the planting within the borders of two great States alone (Kansas and Nebraska) fully six hundred million trees.

Surely the chaos of a mighty world is rounding into form! Long-lived and prosperous be the lot of those who have laid the foundations, and who are developing the agricultural possibilities of this wonderful domain.

INTRODUCTION.

Artificial irrigation is essentially a part of the agriculture of nearly half of our American continent. The subject of the right distribution and conservation of moisture is one that is attracting the attention of the leading cultivators throughout the entire land. Each recurring season of drouth and floods, with its record of failures and disasters, is causing widespread discussion of the best means of arresting the gigantic waste from these sources.

The problem is not only among the first in economic importance, but involves as well a movement towards an improved and scientific agriculture. Thoughtful tillers of the soil are beginning to realize that the waters have "run riot" too long, and that possibly the "settled policy" of the last half century, which has been directed towards relieving both earth and air from moisture, either by drainage or deforesting, should be reversed.

Prominent agricultural writers, almost to a man, are to-day calling a halt, and urging that steps be at once taken to not only arrest the "waste of waters," but to conserve them as well, for use in times of need. Not alone this. The conspicuous and manifest advantage to every grower of crops of a certain and ample water supply, is a most persuasive and powerful argument in favor of artificial irrigation in some form.

Mr. A. N. Cole heads his valuable work on "his system" of sub-irrigation with the double title: "The New Agriculture; or the Waters Led Captive," and declares that "the world seems to have gone stark mad in efforts to dry up and carry off the waters."

He would conserve the moisture and shows marvelous results from his new method. "Sub-irrigate our States and Territories," says Mr. Cole, "and these would feed all the populations of the world. The water wasted annually, were it run through the soils as I am doing, would in from five to ten years suffice to increase the wealth of the country to a degree so manifold, I dare not so much as venture an opinion in estimate."

Mr. Henry Stewart, in his able treatise on irrigation says: "The supply of water then becomes the measure of the fertility of our soil, and

our climate, subject to torrid drouths in the midst of the growing season, is the obstacle to success which meets the farmer, rather than the impoverished soil—a condition indeed mainly due to the poverty of water."

Mr. Hinton, in his recent compilation of "Irrigation in the United States," declares it the opinion of those qualified to form a judgment that irrigation is yet in its infancy, and has given no more than a promise of what it is destined to achieve. "Our own country," says he, "possessing vaster domains than any nation in the world, and of incomparable value, has only to enter upon her own possessions, and by trenching her mountain sides, beget reservoirs as enduring as the foundations of the earth."

Mr. Johnson, of Illinois, who is eminent as a writer on farm topics, asserts it something more than reasonably certain that irrigation on a scale not now dreamed of as possible, will be adopted within a century for the prairies of Illinois.

Orange Judd, and a score of other writers of equal note, are likewise enthusiastic converts to the benefits resulting from the artificial application of water to land. In fact the drift of public sentiment has become so marked in this direction within the past few years as to justify the prediction of a revolution in the present methods of crop culture.

Whatever forecast may be warranted with reference to results on general agriculture, will apply particularly to fruit and garden culture. While it would be an exaggeration to assert that there are no limits to the possibilities of horticulture under an ample system of irrigation, it is certainly safe to say that these limits have not yet been reached.

"Intense culture" will be synonymous, in the future, with a certain and uniform supply of moisture.

Mr. Cole, in the "New Agriculture," reports approximate yields to the acre under his system, of 1,200 bushels of Early Rose potatoes; grapes in proportion of five to one as against the old method; 300 to 400 bushels of strawberries of extraordinary size and flavor, and so on. California vineyardists give returns of yields, often as four or five to one, and enormous production of strawberries. Colorado has produced upwards of 1,100 bushels of onions to the acre (field culture). Colorado also claims the prize beet, a fifteen-pound head of celery, and a yield of grapes from small plots at the rate of fifteen tons to the acre.

Similar instances could be cited almost indefinitely, and while these place judicious irrigation at great advantage, it should be understood that

such results are from favorable conditions and good management. Irrigation may be easily overdone and disastrous failures follow. Mr. Stewart is right when he says that "to irrigate economically and successfully is a business that requires technical knowledge and skill, and belongs to a highly advanced condition of agriculture." Some years ago we wrote the following, which experience since has fully confirmed: "The successful cultivator must know *how* and *when* to apply water to his crops. To the grower of fruits the ability to command this element when needed is of manifest advantage. That the yield may be largely increased by the judicious application of water, there is little doubt. That the fruit may also be increased in size and made more attractive, is equally certain. At the same time judgment is required for the best results. Indeed, positive harm may be done by untimely irrigation; harm not only to the tree and plant, but to the land as well. Incessant watering without regard to the condition of the soil or the needs of the plant will often force a growth of wood at the expense of the fruit product and fruit flavor. It may likewise cause a growth to be made which the succeeding winter finds immature and unable to withstand the tests. This will almost certainly be the result with any tree or plant that has a tendency to make a strong or succulent growth. I have known great injury to result from this cause alone. I have also known the quality of small fruits, particularly strawberries, to be seriously impaired by too frequent watering. This by way of illustrating the point that there is danger in careless irrigation. The condition of the soil and needs of whatever is growing on it should be studied. My own view is that too much water is used by a majority of irrigators in the orchard and garden, and that more harm results from a too free use of it than from too little. In a word, everything beyond a legitimate use is an abuse, and this will be better understood in a few years than it is now."

But, aside from definite pecuniary results, certain general propositions may be stated with reference to irrigation, of which the limits of this work will prevent a discussion. Experience has abundantly demonstrated that water, properly applied, is beneficial, both to soil and to plant growth; that, from a sanitary standpoint, it acts as a purifier, and is injurious only when allowed to stagnate either on or below the surface of the ground, and become the receptacle for unwholesome accumulations; that it is a solvent of vegetable plant food, and often, although not always, acts as a powerful fertilizer, as modern experience, in widely separated regions, is

demonstrating.* That it almost uniformly, when distributed to any extent, increases the humidity of the climate; that it avoids the occurrence of the much dreaded drouth, with its accompanying record of failures, discouragements and often appalling consequences; and, finally, that it makes possible a condition of agriculture so manifestly in advance of the present status of things, that words seem inadequate to express these possibilities.

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*NOTE.—A very probable effect of irrigation on a large scale "would be an increase of precipitation in the region watered. Hitherto, scientific observation has recorded no such increase, but, in a question of so purely a local character, we must ascribe very great importance to a consideration which has frequently been overlooked by meteorologists; namely, that vapors exhaled in one district may probably be condensed and precipitated in another, very distant from their source. If, then, it were proved that an extension of irrigated soil was not followed by an increase of rain-fall in the same territory, the probability that the precipitation was augmented somewhere would not be in the least diminished." (*Man and Nature.* Page 463.) It is asserted that rain-fall on the Isthmus of Suez has increased since the opening of that great water thoroughfare, and has enlarged the evaporable surface of the country. Some leading cultivators of California assert positively that an increase of rain-fall has followed extended irrigation in portions of that State. While this belief is gaining ground, perhaps, in other sections of the country, the fact should be kept in mind that questions of this character, that involve changes of climate, can only be determined by tests extending through a series of years.

THE DUTY OF WATER.

It is safe to say that, at the present time, there is absolutely no standard or basis for accurately estimating the "duty of water." So many conditions are to be taken into consideration in determining how much water may or may not be needed for any given crop, and so little thought has, until quite recently, been devoted to the matter of economizing water, that little data that is at all reliable can be given. Broad generalization, bordering closely on to "guess work," has been the rule. That there are difficulties in the way of arriving at accurate conclusions in these investigations, must be seen at a glance. Local conditions, character of the soils, slope of the land, cultivation, humidity, evaporation, precipitation, drainage and capillary action, are so widely at variance in different localities, that there is small hope of getting any formula that will admit of extended application. Then, too, the demands of plant life are variable.

As no two trees are precisely alike, so it follows that their requirements may not be the same in all respects. Again, the products of different latitudes, even of the same varieties, are influenced by local surroundings. The plant that requires a gallon of water a day in one locality might demand more or less in another. The tree that would drink up five hundred gallons of water per day in Colorado, might be easily satisfied with half that quantity in Illinois.

It would be quite as logical to say that the dweller in the "Land of the midnight sun" should have the same food regimen as the dusky being on the burning sands of the equator, as to assert that products of the vegetable life should have the same treatment the world over. The best, then, that can be done in efforts to formulate conclusions on the duty of water, is to say that, given certain specified conditions, approximate requirements would be the same.

The author of "Man and Nature" says that, "as near as can be ascertained, the amount of water applied to irrigated lands is scarcely anywhere less than the total precipitation during the season of vegetable growth, and in general it much exceeds that quantity."

This is undoubtedly true, and yet it offers no solution of the problem of what the *actual* duty of water is. The amount of water used, and what is really needed, are two very different things. The systems or facilities employed for distribution cut an important figure. Instances are given in California where a flow of one cubic foot per second has supplied 9,000 acres, while in Colorado the average duty is estimated at 50 acres for the same flow.

A Massachusetts man estimates that 108 tons of water are needed per acre, every five days, in a dry period for irrigating the garden lands of that section, and a fruit grower of Wisconsin, who waters his fruits by means of wind-mill and tank, reports that it takes 30,000 gallons to a watering to satisfy his acre of strawberry plants. Under a system of sub-irrigation, the State Engineer of California reported that he saw three acres of young trees thoroughly irrigated, in half an hour, with about four hundred cubic feet of water, or less that 3,000 gallons. The "duty" then, under the flooding process, is vastly less than under the furrow system, and by an improved system of sub-irrigation, it is as a hundred to one in favor of the latter. These are suggestive figures, and some day will be looked into when the waters from our streams become too valuable to waste. It will be a forcible reminder of the old adage that "economy is wealth." Still, even under frugal management, the demands of vegetable life are comparatively large.*

Few people realize the amount of moisture utilized and required by growing plants and vegetation. Dr. Gilbert has stated that the amount of water given off by plants during growth might be approximately estimated as equal to a depth of three inches of rain for every ton of dry substance grown. Another eminent authority found that most plants exhaled during the four or five months of their growth, more than two hundred times their dry weight of water, drawn up from the soil in which they grew.

Prof. Burrell, of the University of Illinois, says, in a recent report, that "the water requirements of a tree, in full leaf, in warm, sunshiny weather, are astonishingly great. A good sized apple tree, having 25,000 square feet of evaporating surface—by no means a large estimate—will give off 31,250 ounces of water per day. This is substantially 250 gallons;

*NOTE.—The experiments now being made at the Colorado State Agricultural College, to determine the duty of water on various crops, will be watched with interest.

an amazing amount, yet far less than has sometimes been calculated. If so much is given up to the air through the leaves, an equal amount must be absorbed from the soil by the roots—the only way that plants of the kind under discussion obtain the water required by them."

Mr. Cole, author of the "New Agriculture," found that a single hill of cucumbers would drink a half a barrel of water in three days time, and, having done so, would begin to languish for want of moisture, and, failing to secure it, die in a week.

It is also known that crops growing on manured land evaporate more water than on the same land unmanured. Likewise land growing a heavy crop of barley was shown by Messrs. Laws and Gilbert to have evaporated nine inches, or 1,800 tons of water more than bare land lying alongside. It will be seen then that the necessities of plant life, with respect to moisture, is a matter that is influenced or governed more or less by surroundings and by local conditions.

Another important point that enters largely into a proper determination of the "duty" of water is the manner of cultivation practiced on any given crop. The plow and the cultivator are most effective conservors of moisture. Hence, crops are saved by frequent and thorough stirrings of the soil, when otherwise they would either perish or fail to mature. This fact is often noticed in the cultivation of corn. When parched and wilted during a season of excessive drouth, I have seen this crop fully restored by a timely use of the cultivator. Among garden crops, the beet and squash are conspicuous examples of the efficacy of good cultivation as a diffuser of moisture.

So important is this item of tillage to the best results on the farm or the garden, that with good soil, deep plowing, and thorough culture, crops may often be assured with little or no surface irrigation. Therefore, it should be said that no discussion, or mathematical calculation of the "duty of water," is accurate or logical that ignores the influence of these local conditions.

In a report of the Farmers' Alliance, of Fort Collins, under date of January 21st, 1888, the recommendation was made that land should be plowed *deep* in the fall of the year, to allow the frost and snow to have full action on the upturned soil. "*It was also demonstrated*," says the report, "*that one irrigation on land that has been plowed deep* was as good as *three irrigations on shallow plowed ground.*" We italicize this because it goes to confirm a position for which we have for years contended. "Deep

and thorough disintegration of the soil," says Professor Cassiday, of our Colorado Agricultural College, "will accomplish the first step in the retention in the soil of the moisture for the sustenance of flagging vegetation. Cultivation, too, checks evaporation, and hence currently lessens the deposit of alkali on the surface. High tilth of the soil supplements irrigation. This, with good under-drainage and the successful application of water to plants in the free soil, and a judicious selection of varieties, may be said to be the foundation of successful fruit culture in this State."

These remarks of Professor Cassiday need not be limited to Colorado. They are of universal application; and while the people of the West are to-day petitioning Congress for a grand system of surface reservoirs for the Great Plains, the importance of which is too manifest to need discussion, let them supplement this by constructing a still grander system of underground reservoirs, by plow and trench, to hold like a sponge the water which falls or flows upon them, to be returned to the growing crops as their needs demand.

From an investigation of results in nearly every part of the country where irrigation is practiced, with few exceptions, the verdict is quite unanimous that "the duty of water" is annually increasing. In fact, so uniform is this testimony that Mr. Dakin, whose able report has been several times quoted from, singles out as an apparent exception to the rule "Colorado alone, in situations like that of Greeley; upon a deep, porous soil, with a rapid fall and quick drainage." Here he says as much water is said to be used now as was required some twelve years ago. "Everywhere else the verdict of experience is that water goes farther every year." But this statement is qualified by another which he terms "an all important principle, as to which there is no question, and which is testified too on every hand—that the more thoroughly the soil is cultivated, the less water it demands."

The remark is made here in passing that this is strong support of the proposition already advanced, that no attempt to determine the actual duty of water will be very satisfactory that does not take into consideration the "duty of cultivation."

Professor Cassiday makes a good point when he says that "the varying efficiency of the duty of water in Colorado, as compared with California and other countries, is largely due to our elevation, causing greater evaporation of both plant and soil." But whatever may be the difference, comparatively speaking, between Colorado and other States

and Territories in climatic influences, we feel warranted in the assertion that this State is no exception to the rule of the increased duty of water, excepting possibly in degree. In the third biennial report of State Engineer Nettleton, pages 59 and 60 (referring specially to the Cache la Poudre River, which waters Greeley and lands contiguous), he says: "The duty for the present season (1886) was about three times as large as the estimate heretofore generally accepted." Total number of acres under cultivation in this district was 125,000, and the average duty for the months of May, June, July and August for this year of each cubic foot per second was 193 acres. Mr. Nettleton then proceeds to make the following general statement: "It is a matter of common experience, however, that the duty of water has increased greatly of late years. The reasons for this will be discussed in another part of the report.* That this duty is not exceptionally great is shown by the experience of Utah under similar climatic conditions, where a duty of 200 acres to the cubic foot per second is not unusual, while in California a much higher duty is attained. * * * * What has been accomplished on this river (the Cache la Poudre) in the way of records on increasing the duty of water, and by reducing the work of dividing waters to a system, which commends itself to all, can be done on other streams and in other water districts."

That seepage cuts an important figure in estimating the duty of water will be seen by experiments made by Engineer Nettleton. In one instance, "starting with a flow of 127,609 cubic feet per second in the canon, before any water was drawn into canals, the volume at the lower point, after supplying fifteen canals, had increased to 214,508 cubic feet per second; showing an addition of more than two-thirds of the original amount, to supply canals further down the valley."

Another experiment on the same river (Cache la Poudre) disclosed the fact that more water passes through the canon during one day in the hight of flood season than there does during a month in the fall. This test applies rather to the matter of storage, and shows the possibility of doubling the capacity of a stream, or greatly enlarging it by ample storage facilities.

*Colonel Nettleton in this reference accounts for the increased duty of water mainly for the reason of the better knowledge from year to year of how and when to apply water, and to the control the State has taken in the distribution of the waters, and in the manner of defining appropriations. In another portion of the report attention is called to the importance of seepage as a factor in the distribution of moisture.

A summary of all this discussion, then, shows that while water may be made to do increased duty in many ways, it also shows the extreme difficulty of arriving at anything like accurate conclusions, in the absence of a knowledge of atmospheric conditions and the numerous local causes or surroundings, that may so directly influence results.

THE BEST SYSTEM OF IRRIGATION.

Irrigation is by no means a modern method of applying water to land. A writer on the subject tells us that "in the regions regarded by general tradition as the cradle of the human race, we find traces of canals evidently constructed for this purpose at a period long preceding the ages of which we have any written memorials. There are in ancient Armenia extensive districts which were already abandoned to desolation at the earliest historical epoch, but which in a yet remoter antiquity had been irrigated by a complicated and highly artificial system of canals, the lines of which can still be followed; and there are in all the highlands, where the sources of the Uphrates rise, in Persia, in Egypt, in India and in China, works of this sort which must have been in existence before man had begun to record his own annals." So says the author of "Man and Nature." Various methods have been employed for artificially applying water to land, some of which appear very primitive and laborious to us of to-day. We read of the "creaking of the water wheels" during the whole night on the Nile in irrigating season, "while the poorer cultivators unceasingly ply the simple shadoof, or bucket and sweep, laboriously raising the water from trough to trough by as many as six or seven stages, when the river is low. Instances of other rude methods are known, such as carrying water by means of pots and distributing it on plats of ground."

These "systems" would not be calculated to awaken great enthusiasm at the present time in the "noble art of irrigation" if they had to be adopted from necessity. But the plans now in use in the United States are mostly copied or borrowed from the improved methods of the Old World. Practically, the history of irrigation in the United States, as Commissioner Coleman says, "begins with the construction of the Pacific railroads." But even with thousands of miles of canals, and rapid development within this brief period, it is safe to say that we have scarcely made a beginning. Hence it is too early to assert what may yet be accomplished, or what may prove the "best" system of irrigation.

This much, however, should be recognized: that there is a vast difference between a system of distributing water and that of rightly applying it to land. For example, there might be perfect harmony of views upon the proposition that the best arrangement for conveying water would be that which would accomplish the work most expeditiously and neatly, with the least loss from any cause, either from seepage, evaporation or the like, and at a cost consistent with a judicious expenditure of money; and yet it would not follow that there must be the same agreement as to the proper manner of applying this water to the land. There is clearly a wide difference here, which will be better understood in the future than it is now. The one simply involves the point as to what would be the most economic expenditure of money, all things considered. The other feature goes farther and requires a knowledge of the needs of the soil and of the crops growing or to be grown thereon. It also demands an understanding of the effect of using water in various ways, whether by flooding, furrow irrigation or by some form of sub-irrigation. In other words, it means reducing the matter to a scientific basis.

This will be *the system* of the future.

As to the merits of the various methods of irrigation, from the knowledge I have been able to obtain, both from study, observation and practical experience, I do not hesitate to pronounce in favor of some form of sub-irrigation, for most horticultural products. To my mind the evidence is cumulative and most abundant, that this way of using water is not only correct in principle, but is the most economic, effective and wholesome. The prime aim, under any system of cultivation, or irrigation, should be to stimulate and induce "capillary action" in every possible way.

It is a fact conceded by every observing cultivator of the soil, that the finest and best crops and most satisfactory results in every way are obtained from those lands where there is free, constant and uniform moisture diffused from below. Soils differ with respect to the workings of capillary attraction, but it is more or less potent in all land.

Three years since Hon. Alfred Deakin, M. P., chairman of the Royal Commission on the water supply of Australia, made an able and comprehensive report on American irrigation, in which he refers to the peculiar property possessed by many soils (capillary attraction) as forming a most important factor in all calculations as to the limits of irrigation. Mention is made of the fact that in California (as shown by experiments) water rises rapidly in coarse, sandy soils, but only to a moderate hight; while in

finer soils, whether in clay or of silty formation, the rise is slower, but higher. So that in a few weeks or months, as the case may be, the water attains twice or thrice the hight that it climbs in the former. He concludes, upon this point, that a "consideration of these results points to the superior value, in suitable soils, of sub-irrigation, or irrigation by seepage from below, over all methods of surface application, because it is thus possible to avoid caking the soil and loss by evaporation."

It may be observed in this connection, and has been already referred to, that broad and deep disintegration of the soil always influences most favorably capillary action.

Mr. Cole, the author, who has truly led the waters captive, declares that "the methods of surface irrigation, when compared to those of subsurface, are as fractions to units."

Says the able author of a book from which quotations have been made (Hon. Geo. P. Marsh), "The readiness with which water not obstructed by impermeable strata diffuses itself through the earth in all directions, shows the importance of keeping up the supply from subterranean sources. The deep-lying veins and sheets of water, supplied by infiltration, from often comparatively distant sources, send up moisture by capillary attraction around the roots of vines and trees. Without the help of artificial conduit, or of water carrier, the Thames and the Seine refresh the ornamental trees that shade the thoroughfares of London and Paris, (paved by flagstone and cement almost impervious to water) and beneath the hot and reeking mold of Egypt the Nile sends currents to the extremest borders of its valleys."

The diffusion of moisture in this way will depend then mainly upon two conditions—the supply received or contained in the underlying strata, and the character of the soil operated upon. Two other points closely allied to these are, the storage capacity underneath and the manner of cultivation.

Now the position has been taken for sub-irrigation for the orchard and garden, without regard to any artificial system for carrying it out.

The objections we urge to surface irrigation, and "flooding" particularly, as commonly applied, are that it is a wasteful, untidy, unskillful and often an unwholesome method of distributing water. That it is objectionable also in rigorous climates, because of its tendency to induce surface rooting, and for the further reason that it is a most effective means of distributing harmful and destructive weeds. Careless surface watering

often results in excessive saturation and caking of the soil and in the injurious deposits of the soluble salts.

In discussing "Irrigation in Horticulture," Professor Cassiday says: "Surface irrigation, whether practiced out of doors or in the plant house, cannot be too strongly condemned, as it unquestionably induces surface rooting—not a desirable result in any climate." Besides promoting surface rooting it induces a continuous evaporation, and refrigeration of the soil, the latter acting as a wick, drawing water by capillary attraction to be absorbed at the surface by the air with which it comes in contact, and depositing at its surface its salts, which, if in too great quantity, are destructive to all useful vegetation. The "furrow system," although often open to much of the criticisms above, is, nevertheless, when used with care and economy, far less objectionable than is the practice of flooding.* Of course, either natural or artificial drainage should go hand in hand with any system of irrigation.

Professor Short, in a paper read some three years since before the Colorado State Horticultural Society, said: "When irrigation is properly carried on, it is undoubtedly the best and safest method of furnishing water to plants. I think the method now used throughout the State is a very bad one."

He then goes on to show that the water used from our mountain streams is laden with the sulphates of soda, magnesia and alumina, which are deposited by irrigating ditches on our lands with the water, and hence, as evaporation takes place, large quantities of these soluble salts remain. After a repetition for several years of this process, a white crust is formed, called "alkali." While a moderate quantity of this so-called alkali is beneficial as plant food, a large accumulation is exceedingly injurious. This is the chief reason that some land, which has been irrigated for several years, will not produce any vegetable growth. As one remedy, he suggests underground drainage, by which superfluous water would sink into the soil (with most of the objectionable salts) and be carried off. Fresh water falling would also aid this. Then, concludes Professor Short, with thorough manuring, the lands would be rendered fit for continual use, as the manure furnishes the phosphates and nitrogenous organic food

*I am aware that frequent and copious floodings are sometimes recommended for dispersing the accumulated salt from lands, but this plan seems open to serious objections, and should never be resorted to where the under-drainage is not good.

for the plants, and irrigating water would supply the soda, lime, potash, etc.

It is possible that the best system of irrigation for this western country, at least, has not yet been discovered. The "New Agriculture" provides for storing the waters in parallel trenches four or five feet deep, and of the same width, below frost line, and filling in these trenches with round stones to the depth of eighteen inches or two feet, tiling to be used if stones are not to be had, then shingling over with flat stones, or tile, or timber. After which, to prevent the earth from filling up the spaces between the stones, any coarse material like straw, hay, weeds, cornstalks or fine brush are placed on. A heavy coating of manure may follow this, and then the excavated soil is placed on top. A series of these trenches are constructed on an incline, one above the other, about a rod apart; these main reservoirs or trenches are connected with smaller trenches, about eighteen inches from the surface, partly filled in with small stones, and designed to connect and convey the surplus water from the trench above to the one below. These are called overflow trenches. Each of these main trenches, then, becomes a reservoir capable of holding three feet or more of water before it overflows into the cross trenches. This is the method by which Mr. Cole would store and conserve the rains and melting snows for use when needed, and it affords an excellent illustration of the principle of irrigation by capillary attraction, or by the gradual and uniform raising and diffusion of moisture from below. Beyond a question it is correct in principle, and I am prepared to believe all the reports of results from experiments at the "Home on the Hillside." As to what extent this system may be utilized in other parts of the country, and under conditions widely different from those where tests have proven so satisfactory, remains to be seen. Mr. Cole not only reports amazing yields under the system, but claims remarkable immunity from disease for all products grown in that way. The expense of fitting the land for this plan amounts to several hundred dollars an acre, where it has been tested, which of itself, appears almost a bar to an extended adoption of the system. But Mr. Cole does not so regard it, and writes under date of Dec. 28th, 1887: "As for cost of fitting lands; were it to cost ten thousand millions to fit under my system the soils of Colorado, as a return interest, at six per cent. would be realized, as near as I calculate, on $900,000,000,000,000,000,000. Don't vote me a crank, now, but wait for a letter I have just written for my ideal paper, your Field and Farm." The progress of the New Agriculture will be watched with interest.

THE ASBESTINE SYSTEM.

This method of sub-irrigation was devised in California by E. M. Hamilton, and is sometimes called the "Hamilton Process." It consists of pipes made of a combination of Portland cement, lime, sand and gravel, laid at a depth of two feet below the surface of the ground, parallel to the rows of trees or vines in an orchard or vineyard. In these pipes, on the upper side, is inserted a wooden plug opposite each tree or vine, the plugs having tapering holes in the center one-fourth to three-eighths of an inch in diameter, through which the water finds exit. Each plug is surrounded by a larger stand pipe, setting loosely on top of the distributing pipe, open at the bottom and reaching to the surface of the ground, for the purpose of keeping the dirt away from the outlet, and rendering it accessible at all times for inspection. The pipes are connected with mains leading from a reservoir. The water finds its way through all the outlets, filling the stand pipes, and slowly percolating to the roots of the plants. No water appears on the surface.

The claim is made for this method, that it effects a very great saving of water over the ordinary means of surface application; that it requires far less time and labor; that it may be used for the distribution of liquid manure; that it does not cause the ground to bake with the heat of the sun—no water appearing at the surface; that no grading is necessary; that the growth of weeds is checked; and, finally, that it induces deep, instead of shallow, rooting, as is the tendency with surface irrigation.

The further claim is made that, by keeping the water from standing on the surface of the ground, injurious deposits of alkali are avoided. These points are strong, and if they can be sustained, which is by no means improbable in many localities, the system is destined to great popularity and usefulness. In many parts of California it is giving much satisfaction.

The Australian member of parliament, Mr. Dakin, from whose report we have already quoted, in commenting on this system, after a mention of the fact that irrigation beneath the surface, if not excessive, is considered the most perfect method of supplying water to vegetable life; because it can avoid the dangers of over-saturation, surface caking, and of washing out the richer elements in the soil, as well as accomplish an enormous saving in water, says: "It certainly appears that sub-irrigation is the hope of the most intelligent irrigators, because it promises a great economy of

water, and the most direct application of it to the thirsty tree that it is possible to devise."

The difficulties that naturally suggest themselves in the way of complete success in this plan are the liability to have the pipes stopped up, either by tree roots or sediment. The advocates of the system claim that both of these dangers have been anticipated by ample provision for either guarding against or clearing obstructions of this kind. Nevertheless, it is probable that in some localities obstructions similar to those named might be serious drawbacks to the successful working of any system of conveying water by pipes. But that all these hinderances will ultimately be overcome, there seems little doubt.

The Asbestine system is attracting wide attention at the present time. Professor Cassiday makes favorable mention of it, and thinks that at this altitude, where surface evaporation is rapid and water quickly dissipated, for this and other reasons already pointed out, that "sub-irrigation offers positive advantages." At Gardenside we have tested the method in a small way only, but see no reason why it may not succeed.

It will be more fully tried here. But the man who has given it the most thorough trial in Colorado is Mr. Gravestock, of Canon City, and we have let him tell the results in his own words.

If those interested would give this, or any similar invention, a trial, first in a small way, under different conditions of soil and location, in a few years we would be prepared to speak understandingly of its merits for this region.

SUB-IRRIGATION.

CANON CITY, COLO., December 5th, 1887.

Your letter is received. With reference to sub-irrigation, will just say that this is the fourth season I have tried it, and I cannot speak too highly of it. I have in only about a thousand feet, but enough to satisfy me that when properly applied it is a grand success in Colorado. Had not my fruit trees and grape vines been so old, I should have put my whole place into sub-irrigation, but as my orchard and vineyard was full of roots, I was afraid of doing it an irreparable injury by cutting too many roots in digging trenches to lay the pipe.

I have three short rows, of a little over 300 feet in length, to which I have planted one row of standard pear, one row of plums, and a row of grape vines between and each side of my fruit trees. All have made a

remarkably fine growth this season. My young plum trees especially have made a growth this year of nearly six feet of fine, stout wood and well ripened up. Some young Salem and Duchess grape vines, four years old, made a growth of over twelve feet this season, although they have been attacked a good deal with the grape leaf hopper. As for conducting water long distances, the cement pipe cannot be beat, neither for durability, cleanliness or cheapness.

Sub-irrigation is away ahead of surface irrigation. I would put it about as far ahead as surface irrigation is of the old hand watering-pot we used to use when we were boys, with our wet legs and tired arms and back.

From the same writer, December 23d:

With reference to size of pipe, will say that the laterals for distributing the water are 2-inch bore; the main, that laterals are attached to,

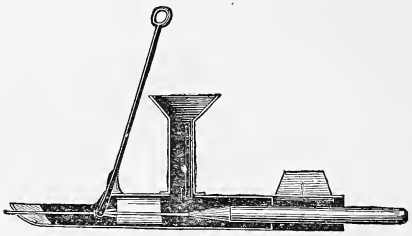


Fig. 1.

Figure 1 illustrates the machine used in making this cement, and the manner in which it is done.

are 3-inch bore. Trenches are dug 16 inches deep and 16 inches wide for convenience of laying pipe.

As to your second question—how often to irrigate—will say: If I had an orchard of young trees, just planted, and to be irrigated by this method, I would, the first season, irrigate once a week. Say let the water run from one hour to one and a half, according to nature of soil. After the first season, once every ten days or two weeks would be quite enough. This, I think, has proven to be enough on my soil, which is a sandy loam. As to suggesting any improvement in the method, will just say that if the plugs were four to six inches above the pipes, instead of two, it would certainly

be better, as grit and small pebbles would not be so apt to get in the plugs to affect the discharge of water.

I don't know of a single instance where I would prefer the old method to sub-irrigation, except for corn and grain growing. As to expense per acre (that's the place where the shoe pinches), this depends a good deal on circumstances—whether you want to irrigate orchard, vineyard or garden; and another big item is the price at which you can get Portland cement. One barrel of cement and one barrel of dry-slacked lime, free from lumps, will make about 350 feet of 2-inch pipe. By using seven parts sand (must be clean), one part Portland cement and one part lime, will make 350 feet of good 2-inch pipe; so you can easily figure for yourself what it would cost per acre.

PIPES, CONDUITS, ETC.

The use of pipes, flumes and lined channels, for conveying water long distances, will ultimately come into extensive use in all sections where water is scarce and costly.

Few of us realize the enormous losses by seepage and evaporation in conveying water by means of opens canals and laterals. Mr. Dakin estimates this waste at from 25 to 50 per cent., and cites one instance where it was far greater—a canal in the San Joaquin Valley, which took 90 cubic feet per second at its head, and only delivered 14 cubic feet per second on the farms 28 miles away. "Some put," says Mr. Dakin, "the loss of farmer and canal proprietor together as high as nine-tenths of the water diverted, others at three-fourths, and it is rarely calculated at less than the latter figure."

Professor Mead, who fills the chair of Physics and Engineering in the Colorado Agricultural College, calculates that the atmosphere takes up from the surface of the Poudre district (in Northern Colorado), during the months of June and July, at least one thousand cubic feet of water per second.

It is evident, therefore, that the time is not far distant when, instead of open, excavated channels in the soil for conveying water, closed or impervious piping, flumes and the like will be largely employed.

In California, according to Mr. Hinton's report, the following conduits are used: (1) Wooden flumes, (2) lined channels, (3) wrought iron riveted asphalted pipes, (4) wrought iron asphalted pipes, (5) terra cotta pipes, (6) cemented pipes, (7) asphalt pipes. Of course, whatever is selected for this purpose must be able to resist the action of the salts as well as of the elements.

RESERVOIRS, WELLS, ETC.

It seems evident that the reservoir or storage system, for supplying water for irrigating purposes, will enter into the agricultural economy of this country to an extent not thought or dreamed of as possible to-day. Not only will the Great Plains—"the possible homes of fifty million people"—be supplied from mountain and upland storage, but the system will extend, in one form or another, through the broad acres of the Great Northwest, and even to all sections of our land. The waters will be conserved, "led captive," and utilized in a hundred ways, of which we have not, perhaps, the remotest conception.

China is said to have one irrigating canal a thousand miles in length, and other nations of the Old World are close rivals. The extent to which storage is practiced there can hardly be realized by us, but it is sufficient for us to state here that the most sagacious minds of all those lands early saw the importance of a certain and ample system of water storage to the permanent welfare of the people.

Storage, then, with improved methods of conveying water, will be a leading problem in the agricultural development of this nation for the century to come.

Much can and will be done, in a limited way, by means of artesian wells, wind-mills, steam pumps and hydraulic appliances for raising water connected with distributing pipes.

In Syria, extensive vineyards are irrigated from large wells dug for that purpose. And in portions of the southern San Joaquin Valley, California, irrigation from artesian wells is relied on largely. One well, bored to the depth of 310 feet in 1879, was made to water successfully a 40-acre tract of land set to forest trees, and it is claimed that some of the wells in Tulare county, with an average capacity of 247 gallons per minute, will water thoroughly 160 acres of land. The average flow of the wells in this county (Tulare) are given as two and one-half inches above the casing. These instances serve to show the possibilities of irrigation by artesian wells in specially favored regions, where geological and surface formations are favorable.

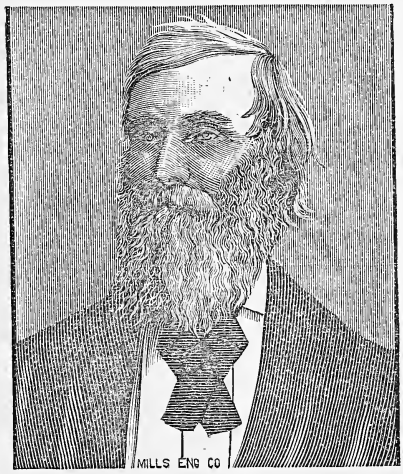
For small tracts (under close culture) of one, two, or even five acres, the wind-mill, with large tank or reservoir connected, is now used in different portions of the country for supplying water. In this case, iron or cement piping, or wooden conduits, are employed for conveying the water where desired.

Wherever the Asbestine system is practicable, and a supply of water amounting to from 25,000 to 100,000 or more gallons can be stored, by means of wind-mill, steam pump or hydraulic power, a considerable tract may be watered. Reference has heretofore been made to the fact that, in one instance in California, three acres of young trees were thoroughly irrigated in half an hour by this underground method, and with less than 3,000 gallons of water. This, of course, was under highly favorable conditions.

But the promoters of the Asbestine plan assert that an artesian well with the capacity of 100,000 or 150,000 gallons daily, will readily supply all the moisture required on a farm of 160 acres. This statement is given, not for the purpose of intimating that this claim has been sustained, nor to endorse the assumption that the system is practicable for the needs of general farming, but with the sole object of illustrating the possibilities, even of the artesian well, wind-mill or steam pump, with the right appliances for distributing the water so supplied. Great improvements may be safely anticipated in this direction, as well as in the building of mammoth canals and gigantic reservoirs.

JUDGE JAMES MARSH CLARK,

Whose portrait is given on this page, was born in New York City, December 8th, 1810, and has been an earnest, enthusiastic horticulturist all his life. He inherited a love for this calling from a long line of ancestry, dating back prior to the days of the American Revolution. At an early age he had charge of the planting of an orchard for his uncle in New Jersey. A little later he pushed westward, and in 1828 planted



quite an extensive orchard in Indiana. A few years later, in pursuit of health, he moved to Wisconsin, and was among the earliest planters in that State—first at Fon-du-lac, in 1840, for a friend; near Madison, in 1841, for himself; and afterwards near Baraboo, in 1847. At this last named place he resided twenty years, and achieved such remarkable success as an amateur fruit grower that in a few years he was able to show one hundred varieties of apples alone grown in that trying climate.

This success was not only the marvel of his own section of the State, but became widely known in other parts; and in 1867 he was awarded first prize by the Wisconsin State Horticultural Society for the largest and best collection of apples grown in that State; also several special premiums for best varieties for different seasons and localities. All this was accomplished while Judge Clark was holding responsible official positions. In 1861, being severely prostrated by ill-health, he made a trip to Colorado, and in May of that year planted an orchard in Boulder County for James Maxwell, a prominent citizen of Boulder City, and the father of Hon. James P. Maxwell, also of Boulder. This, so far as I can learn, makes Judge Clark the pioneer fruit planter of Colorado.

Subsequently, in 1861, he returned to Wisconsin to lend his influence and aid to the cause of the Union in the Great Conflict which followed. In 1867 poor health again prompted him to seek the milder climate of East Tennessee. Here he at once planted an orchard; but his surroundings not being congenial, in the chaos that followed the war, he moved to Kansas in 1869, and was the first orchardist in Oswego Township, of that State. From Kansas Judge Clark came to Colorado again in 1871 and joined his fortunes with the Union Colony of Colorado, locating permanently at Greeley, where he still resides.

True to his faith and tastes he brought a considerable stock of fruit trees and plants, at large expense, and at once proceeded to establish his favorite fruit garden. Here he has remained with his noble wife, surrounded by a prosperous and influential family of children, among whom are J. Max., and A. B. Clark, well known as leading farmers of Northern Colorado. Year after year "Father Clark" has experimented with various new varieties and added to his already choice collection of hardy horticultural products. Notwithstanding his advanced years, he is still active and enthusiastic, and believes that one should never be too old to plant a tree or shrub. As he said to me the other day: "I was scarcely ever in a state a week without planting (if health and season permitted) tree or fruit stock of some kind; and aside from any benefit that this may have been to others, I am confident that my active interest in this work has prolonged my life at least twenty years." An acquaintance of Charles Downing, a contemporary of Marshal P. Wilder, the father of John J. Thomas, and a score of other distinguished men in pomology, Judge Clark has had unusual opportunites for study and observation, and has improved them well.

The following incident in connection with the subject of this sketch is given to illustrate his deep devotion to his loved vocation:

Arbor day, 1886, was observed by the various schools in and about Greeley. A procession of all the children was formed at the main building and they marched from one school house to the other, each grade planting as many trees as there were classes, about their building. Bringing up the rear of the long line of school children, mostly dressed in white, was "Father Clark," carrying in one hand a spade, in the other a two-year-old apple tree, which, with his own hands he planted at the Second Ward school house. It was indeed a beautiful picture to witness the silver-haired veteran of seventy-six years, surrounded by many children, planting a tree, and it left a lasting impression upon those witnessing the scene and who listened to the remarks of the sage as he addressed the children: "I plant this tree, not with the hope or expectation of myself seeing its fruit, but for your benefit, my children. Doubtless there are many here to-day whose children may enjoy the fruit and shade of this tree. Thus may you learn the lesson—'Do what you can, though never so little, for the good of those who come after us.'"

The children responded heartily in song, singing, "Swinging 'neath the old apple tree."

All honor to the men who are contented to sow and to plant that others may partake of the fruits of their honest toil and unselfish devotion to a noble calling. A cultured, modest man, a skilled pomologist and a lover of mankind, "Father Clark" has lived to ripe old age and has served well his day and generation.

THE ORCHARD.

The average Colorado soil will do for the orchard and garden, but if one has a choice in this particular, preference should be given to rich, deep sandy loam, with a clayey, sandy sub-soil; and if there is an opportunity for a choice in exposure, select a north or northeast slope for the orchard.

It is useless, however, here in the West, to insist on either of these preferences, as the "lay of the land" is, in so many cases, nearly level over wide stretches, and the ideal soil is not always to be found. Any land that will produce good general farm crops can usually be relied on to grow good trees, and while a northern slope tends to protect against the action of a hot sun and to avoid premature growth in the early spring, still, with care and good culture, natural obstacles or disadvantages may be greatly modified, if not overcome.

Upon the subject of soil adaptation, I quote from Mr. P. Barry, a recognized authority: "For an orchard of apples or pears, a dry, deep, substantial soil, between sandy and clayey loam, and possessing among its inorganic parts a considerable portion of lime, is, according to all experience, the best. On such soils we find the greatest and most enduring vigor and fertility, the healthiest and hardiest trees, and the finest and best flavored fruits. The plum succeeds best, as a general thing, on a clayey loam, rather stiff. * * * The cherry, peach, apricot, nectarine, and almond, require a light, dry and warm soil." He further says: "There are two points to be observed, under all circumstances, in regard to soils. They must possess the inorganic substances, such as lime, potash, etc., that constitute a large portion of the wood and bark of fruit trees, when burned, and a sufficient amount of organic matter—vegetable mould, which dissolves and furnishes materials for the formation and growth of new parts."

If the land chosen has not been cultivated, a good plan is to grow a potato or corn crop the season before setting the trees. This tends to subdue the soil, and make it of better texture for planting. In any event, it is desirable to break the land the season previous to setting. If this is

to be done, turn the sod under rather shallow in midsummer, or when the native grass is most thrifty, and in the autumn plow again, this time length-wise of the furrow and deep enough to bury the sod several inches. The point is not only to have the soil subdued and mellow, but to have the native growth turned under so that it will decay and fertilize the land.

The following spring, before planting, run over the land with a heavy harrow, to smooth down lumps and level up for the trees. Previous to this, however, see that the right grade is established for irrigation. Every arrangement in connection with the orchard, of course, should be consistent with convenience in irrigating.

There are various ways of laying out an orchard, some of which involve considerable work and painstaking care. But the first and most important considerations are to have the trees well planted, and in a manner consistent with good cultivation and a proper regard for economizing space. After this the matter of general appearance may be considered. If one is not particular about perfect accuracy or range in the plan, a very good as well as expeditious way is to mark out the ground with a plow, running furrows at desired distances each way.

This can be done with reasonable precision by the aid of stakes at regular intervals, to enable the plowman to keep his bearings. If one wishes to plant so that the trees will range perfectly, not only each way, but diagonally, the following plan for laying out, as given by Mr. Thomas, in "The American Fruit Culturist," is quite simple and easily accomplished:

"The following mode of laying out and planting will not require one-twentieth of the labor commonly devoted, and will give rows that will range perfectly, not only in both directions, but diagonally. The writer has found that two men would thus lay out from thirty to forty acres in a day, with perfect precision, for planting.

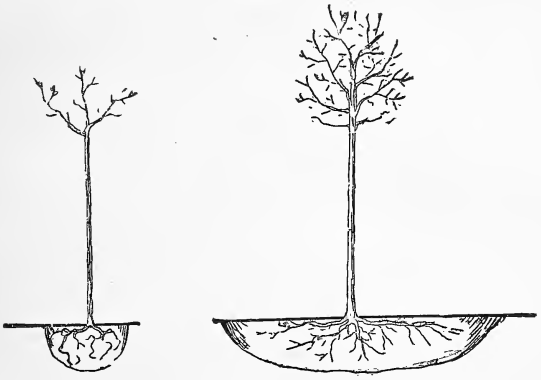
"The first thing to do is to procure as many short pins or stakes, a few inches long, as there are to be trees in the orchard. These may be made by simply splitting short blocks or boards with an axe, say half an inch in diameter; or corn cobs will answer a good purpose, and may be more easily seen. Then procure a strong cord, as long as one side of the orchard, or, if the orchard is very large, as long as each section may be, if necessary to divide it. Then, with a pole or measure, mark off the distances of the trees on this line, sticking a common brass pin through at each place for a tree, bending it around the cord so that it will not come

out. Red yarn sewed through and tied around the cord would be more visible than pins; but the latter are quickly found if the workman measures the distance by pacing between them as he walks from one to the other. A new cord will stretch a little at first, but will soon cease to do so. The easiest way to mark the spaces on the cord is to wrap it around the ends of a board cut at the right length, so that every third coil will be a place for a pin. Thus, if the board is five feet long, by marking every third coil at the end of the board, we obtain spaces of thirty feet. The field having been plowed and fitted for planting, we are now ready for operation. Select a still day, so that the wind will not blow the cord out of place, and then stretch the line along one side of the field, at a suitable distance from the fence where the first row is to be made. Make it as straight as possible, by drawing on it forcibly; a stout cord is better than a weak one on this acoount. If the land is tolerably level, twenty or thirty rods may be measured off at a time. Place flat stones or other heavy weights upon it at intervals, to keep it in position; if there is some wind, care will be necessary in making it perfectly straight before thus fixing it. Next, drive in one of the short pegs or sticks at each point marked by the pin already described. When this is done, one row will be marked, then remove the line, and mark each end of the field at right angles to this in the same way. Lastly, mark the remaining side. Before marking both ends, it is safest to stretch the line on the fourth side, that all may be perfectly spaced. Next, to fill up this hollow square with the proper marks, stretch the line successively between corresponding sticks on the opposite sides, and mark as before till the whole is completed. If the work has been carefully done, every stake will be found to range perfectly. Every cord will stretch more or less, but if stretched so that the ends will come even each time, which is attended with no difficulty, the rows will be perfect.

"Next, take a strip of board, say about eight feet long and six inches wide, and cut a notch in one side at the middle, just large enough to let in the stem of a tree. Bore a hole through each end, exactly at equal distances from this notch. Then, whenever a tree is to be planted, place the middle notch around the peg, and thrust two other pegs through the holes at the ends. Then take up the board, leaving these two pegs, dig the hole, replace the board, and set the tree in the notch. Proceed in this way till the whole orchard is planted. It is obvious that the trees will stand precisely where the first pegs were placed, and will range in perfect

rows. A large number or series of the two pins may be set successively by the board, so that a number of workmen may be digging and planting at the same time. It is of no importance in what direction the board is placed, as the pin and tree will occupy the same spot."

In addition to marking out with the plow, as already described, when everything is in readiness for planting, the work may be hastened and made effective by running a sub-soil plow along the furrows. This not only serves to excavate the ground for the reception of the trees, but it combines in a measure the advantages of trenching, with deep stirring and pulverizing of the sub-soil. It is practiced by some of our most suc-



A badly planted tree A well planted tree.

cessful orchardists, and among them David Brothers, of Jefferson County, Colorado, and is especially to be commended in all sections subject to scarcity of moisture or of water for irrigating purposes. If the soil is not of the best, this preparation may be advantageously followed by filling in the bottom of the trench with a few inches of well-rotted manure, over which a covering of top soil should be placed before setting the trees. But whether manure is applied in this way or not, the deep furrow will have to be filled up to the proper depth for planting, as of course the bottom of the trench would be too deep for young trees. After this preparatory work the planting can be readily accomplished. In

small gardens the line and spade would have to be used instead of the plow.

Go down well in digging holes, and make the excavation broad and deep, and have the soil mellow, so as to give the roots of the tree ample room. Trenching or sub-soiling may precede this preparation, but it should be understood that there is some hazard in highly enriching the soil for young fruit trees. It often forces them into a strong growth which a succeeding unfavorable winter finds immature, and serious injury results. This caution is dropped here, but manuring will be referred to again further on.

Before setting the trees, pare off smoothly all torn or mutilated roots by a slanting cut with a knife, then place the tree in the hole at about the same depth that it stood in the nursery row, if anything, in this climate, a trifle deeper; spread out the roots in their natural position. Be sure to have the soil in the bottom of the hole moist and mellow. When the tree is placed in position (and if the site is level and exposed to the direct rays of the sun, it is well to incline the top a little towards the South-west) fill in around the roots with fine soil, and occasionally raise the tree a trifle so that the soil may be well worked in. As the dirt is being thrown on, press firmly with the foot until the hole is filled up. If water for irrigation is not immediately at hand, it is well after the hole is partially filled to pour in a half-bucketful or so. But this need not be done if water can be turned in the laterals and allowed to saturate the ground, and thus fully settle the soil around the roots. Very cold water, however, should be used sparingly, if at all, where it comes in contact with roots of any kind.

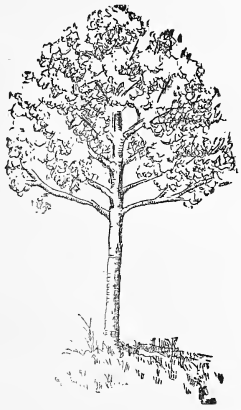
In transplanting or removing trees from nursery, *never* expose the roots to the sun or dry winds; keep them moist at all times. This is a very essential precaution. Right here the first fatal mistake is often made in handling trees and plants. When the planting is done, it is often beneficial to place around the tree a liberal coating of coarse litter or manure, but never permit green manure to be placed in contact with the trunk of the tree.

PRUNING.

A young tree that has been properly grown in the nursery will need very little pruning at the time of transplanting. As already stated, in transplanting all mutilated roots should be dressed by cutting back to the sound wood with a smooth, slanting cut, "on the under side of the root."

After this is done, to preserve the necessary balance between the branch and the roots, authorities agree that the branches should be cut out and shortened so as to correspond with the condition of the roots. In other words, leave enough branches only to form a compact (not crowded) head, and cut these back, say one-third, or to within a half-dozen buds of the base of each of the branches. By this treatment your tree ought to have a good start. But trees differ so much in make-up and habits of growth that it is almost impossible to give specific directions about pruning, and this is especially true when we consider the different aims sought by the practice.

All things considered, the low-headed, stocky trees are safest for the plains, and those portions of the West exposed to sudden and violent



Well Formed Lowheaded Apple Tree.

extremes of temperature. They are self-protecting, and in a measure prevent sun scald, and the trunk and earth immediately around from becoming overheated in the spring, and inducing an early rise of sap.

If trees are to be headed high in large orchards, except in favored situations, the trunks should be protected from the action of the sun.

If the tree is taken up with roots well preserved, there will be little necessity of severe pruning or cutting back. The use of knife or saw on any tree should be avoided as much as possible. If taken in hand when

young, the top may be formed easily by pinching off the heads where they are not needed.

Pruning may be done in autumn after the fall of the leaf, also during the winter and the early spring. Mr. Downing, the eminent horticulturist, says: "We should especially avoid pruning at that period in spring when the buds are swelling and the sap in full flow, as the loss of sap by bleeding is very injurious to most trees, and in some brings on a serious and incurable canker in the limbs."

In removing a limb, cut just outside of the crown or collar. This is quite important. The collar is a small ridge of bark to be seen on limbs near the body of the tree.

If severe pruning must be done, especially in the established orchard, where large limbs have to be removed, it is very important that the wounds heal early. In such cases summer pruning should be practiced. It may be done either when the tree is in partial leaf, or when in full leaf and blossom. The former is probably the better time. I would not recommend much winter pruning in any locality where the winters are severe, for the reason that fresh wounds render trees liable to injury from extreme cold.

In removing large limbs, always first make a cut on the under side, to prevent splitting or peeling off the bark before the limb is fully severed. This will occur if knife or saw is used on the upper side before the lower cut is made.

An excellent preparation for covering wounds made by pruning, is gum shellac dissolved in alcohol to the consistency of paint, and applied to the wounded surface with a small paint brush.

After the orchard has been planted, unless the soil is moist and mellow and in prime condition, the trees should be immediately watered. It is best to run furrows at once with a shovel plow, or other suitable implement. Have these sufficiently near the trees so that the moisture may be easily diffused around the roots when the water is turned on. If the soil is rather heavy and compact, it is sometimes best to make a trench or basin around each tree to have the soil properly saturated. Use a sufficient volume of water to run slowly along the rows, and when it it completely through, and the ground around the trees deeply moistened, shut the water off; never let it remain and soak and flood your grounds. Where a mixed orchard is to be planted, care should be exercised to lay it out so that those trees which require the least water will receive the

least, and vice versa. Plant the cherry trees, for example, where they will not be subjected to too much irrigation. Next to them the pears and peaches. Apples will need, on an average, watering once every week or ten days the first season; and the second, perhaps every two or three weeks. Most varieties of plums rejoice in abundant moisture, and hence should be freely watered.

It is a good plan to go over the ground after the soil has settled from the effects of the irrigation, before it has dried much, and fill in around the trees all depressions made by the water with fine, dry earth. This will tend to prevent the soil from baking, as well as to arrest evaporation. A slight, basin-like depression should be left around the tree, to assist in retaining the moisture that falls from the clouds.

The established orchard will require irrigation according to the soil, location, cultivation and treatment it receives. For this reason each orchardist must be his own judge to a great extent. It is safe to say however, that from one to three thorough applications of water each season will be ample on an average. The soil should at all times be kept mellow and free from weeds in young orchards.

Garden root crops, potatoes and the less rank growing varieties of sweet corn, may be cultivated to advantage for a few seasons, but should not be planted too near the trees. Never sow grain crops in the orchard, they not only exhaust the fertility of the soil, robbing it of the elements of plant food needed to sustain the trees, but they are enormous consumers of moisture. It is a rule, with rare exceptions, now recognized by leading cultivators everywhere, that water should be witheld from the orchard after the season's growth has been practically made, (which in Colorado is by September 1st) to allow this growth to fully mature. But the last thing before the ground freezes, to give a copious irrigation, in order to place the trees in good form for our usually open winters and uniformly dry atmosphere. This precaution is an important one, as it enables fruit stock to resist the drying-out process so fatal to trees everywhere.

MULCHING.

It is always safe to give the surface, for three or four feet around the young tree, a dressing of coarse litter, cut straw or partly decomposed manure, and this should by all means be done if the soil is of a heavy, coarse texture and not in good tilth. Green, fresh manure, however, is

not desirable and should never be placed in contact with the body of the tree. There is less necessity of a dressing where the soil is naturally warm, deep and mellow, with a moist, sponge-like sub-soil. This kind is in a measure self-protecting, because it not only keeps the surface of more even temperature, but brings about a most desirable condition—that of deep rooting.

But where trees are to be planted in situations unprotected from the direct action of the sun and the elements, mulching should always be applied. The advantages are that it tends to guard against sudden extremes of temperature, to retain both surface and capillary moisture,

MANNER OF PROTECTING THE TRUNKS OF TREES.

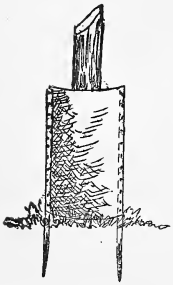


Fig. 3. Gunny-sack or Burlap.

Fig. 4. Heavy paper.

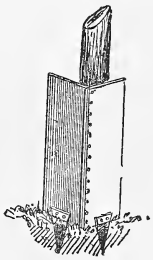


Fig. 5. Boards.

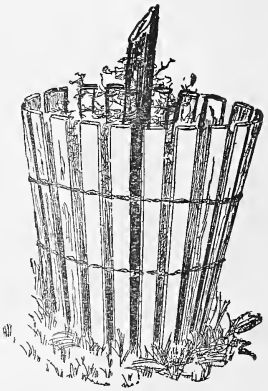


Fig. 6. Stakes or lath.

protects from the at times too powerful and long continued heat of the sun, and in other ways equalizes conditions. Whatever virtue there may be in the atmospheric ammonia given off by the rains, or in the substances deposited by the irrigating waters, the mulch assists in utilizing. The generally accepted theory is then that a good mulch both operates as a protection and a fertilizer.

Mulching does not retard the blossoming period in trees as was formerly supposed. It could have this effect only where the tree was entirely

covered. In other words, placing a protection merely on the surface of the ground, does not control or perceptibly influence the top with respect to the development of fruit buds and bloom. This has been abundantly demonstrated in Colorado. The chief objection to the practice is that, under a system of surface irrigation, it tends to encourage shallow rooting. For this reason when applied to trees for any considerable time it must be continued. Where sub-soiling, or trenching or under-irrigation is adopted, the objection would in a measure be obviated. Therefore, in a dry climate with open winters and almost perpetual sunshine, where solar and terrestrial radiation are most marked and evaporation active, we believe that the benefits of judicious mulching are far in excess of its disadvantages. At the same time this should not supercede cultivation. The soil should be frequently stirred and the weeds kept down, always using care not to injure the roots or body of the tree.

In addition to this it may be necessary to enrich the land by an annual application of well-rotted manure or compost carefully worked in around the extremities of the roots. This should always be done if the soil is light or impoverished from any cause. Never let the trees lag for lack of plant food. This will apply to old as well as young orchards.

After the details of planting are attended to, it will pay the planter to protect the trunk of every tree in some one of the ways illustrated. The action of the sun's rays on the South and West sides of the tree is often very harmful. Any heavy building paper may be used for making the protection shown at Fig. 4. If tarred paper is employed, there should be a space of two or three inches between it and the bark of the tree, and a still safer plan is to line the inside of this with white paper of some kind. Never place tarred paper directly in contact with the bark of a fruit tree. When properly used, it is a valuable protection not only against the sun's rays, but against depredations of rabbits and insect enemies of tree trunks. A convenient way of protecting the cherry, plum and peach tree is by wrapping a gunny-sack around the trunk and winding it with twine. A prominent fruit grower of the East protects his trees from mice, rabbits, etc., by cutting fine wire netting, such as is used for window screens, into strips 18 inches broad, then into lengths to surround the trees, letting them lap over considerably. He says this will also protect the tree from the borer.*

*Trees are often protected by simply wrapping them with light paper or straw, or with strips of bark of various kinds; but it is better not to have any protection remain too long in contact with the trunk of the tree.

WIND-BREAKS OR SHELTER-BELTS.

Plant by all means, either in advance of or simultaneously with the orchard, a shelter belt of trees. Rapid, upright growers should be set for this purpose, either all round the orchard or on the sides from which come the prevailing winds. The Lombardy poplar, where it does not kill back, makes an excellent wind-break. The western or gray willow is about as good, and still hardier. The cottonwood makes a stronger growth than anything that can be planted, and hence a quicker protection, but it is a gross feeder and should not be set within several rods of an orchard. The black and honey locust are also used.

Some of the strong growing crabs are also desirable. For an inside row of a shelter-belt (I prefer this word, because it means more than simple protection from wind), a row of hardy plum trees may be planted. Evergreens are good where they can be cheaply obtained. Mr. Grimes, the well-known Denver nurseryman, "thinks a wind-break is as incomplete without an evergreen lining as a bird's nest is without a lining." Here, in Northern Colorado, I would surround the entire orchard with a shelter-belt, but protection is most needed on the North and West sides—not alone for the teees, but to protect the fruit buds and fruit from injury by occasional prolonged and drying winds.

HEELING IN.

It is often desirable to procure fruit stock in fall and *trench in* until spring. This practice is growing in favor, and one nurseryman of large experience declares that trees treated in this way not only retain the full vitality they have in autumn, but are actually worth twenty-five per cent more than those taken up in spring.

To *heel in*, put trees in a sloping trench, with roots at deepest end ($1\frac{1}{2}$ to 2 feet deep). Spread out roots, and cover thoroughly and closely with fine, moist earth and fill in trench, covering tops of trees with about six inches of dirt, leaving mound that will turn water. Always bury on a well-drained site. We usually wet roots before trenching.

Should trees arrive dry and shriveled by reason of delay or from other cause during shipment, if water is convenient put them in root and branch, and let them remain for several days in water, or bury them deep in moist earth. This practice will usually restore the stock fully. If frozen, do not unpack on arrival, but place in cellar or other cool place, free from frost, and let them remain until entirely thawed out.

The following extracts are from a paper read recently by Dr. Alexander Shaw, before the Northern Colorado Horticultural Society, at Fort Collins. The special subject was the practicability of apple growing in Northern Colorado, but it will be seen that the paper covers a general scope:—

For the last four consecutive seasons I have made a tour of inspection of the State of Colorado, for about six weeks, for the express purpose of being able to respond to this inquiry, not only as to North, but also as to the South. The State is a State of magnificent distances, in range of area from North to South about 600 miles. The area of the State East of the Rocky Mountain range is about 47,000 square miles, aggregating about 30,080,000 acres. Altitude does not limit the possibility of apple growing. I have found the Ben Davis and Oldenberg apple growing at an altitude of near 8,000 feet, also at 4,500, all seemingly alike matured.

The meteorological influences necessary to grow fruit are not governed by altitude alone, but the contour of the ground and surroundings play an important part. The era of fruit growing in Colorado dates back to about twenty-four years. William Lee, of Jefferson county, near Clear Creek, is probably the pioneer fruit culturist of Colorado. He hauled his first stock by mule team in 1863 from Iowa City, Iowa; 1865 was the date of the next fruit growers' venture. George Webster, M. L. McCaslin and others in the St. Vrain Valley purchased their stock from the Atchison nursery, Kansas, which were hauled by ox teams. About the same time Jesse Frazer, of Florence, Fremont County, hauled his first stock by ox team from Quincy, Illinois. Frazer has been pre-eminently the most successful apple grower in the State, having the largest plantation of aged trees in the State, being about three thousand trees, which produced a crop of about ten thousand bushels for the year 1886. From the several points, as above named, have radiated fruit planting with a varied success. There is no meteorological cause preventive of fruit culture in Colorado but what is found in any of the States East of us.

The weather records of the government show less extremes of heat and cold, and more bright, sunshine days in Colorado, than any other State of the Union. The mean line of temperature, as indicated by our signal stations, from North to South, passes through Denver. As to the climatic causes preventive of fruit growing, we are favorably situated. At the present date fruit growing has been tested successfully over an area from North to South of about 500 miles. Each locality within that area

has its off years, with more or less success. Jefferson, Boulder and Fremont have been testing fruit culture, both as to small and tree fruits, for over twenty years, yet one has had its barren years from climatic causes as often as the other. For instance, one orchard of aged trees for the year 1886, at Canon City, failed, while in the Longmont neighborhood they were pre-eminently a success, yet for the current year of 1887 the fruitfulness was reversed. Frazer's orchard in 1886 produced 10,000 bushels, yet in 1887 had not more than fifty bushels. With the conditions precedent to successful fruit growing, such as water, at command, the right kind of soil, proper care and culture, I know no reason why fruit growing in Northern Colorado cannot be as successfully done as in the Southern counties, except some of the stone fruits, such as peaches, apricots, nectarines, and some of the tender varieties of cherries, and possibly plums. The better varieties of plums and cherries in Northern Colorado are at present on probation. Pears, in many sections of the State, at proper age, are a success, and I know no reason why they should not rank with apples as a success. The home of the stone fruits, as above named, in Colorado, will be in the extreme South and in valleys West of the Rocky Mountain range on the tributaries of the Gunnison and Grand Rivers.

It is possible that peach trains in the near future will run from Western Colorado as well as Salt Lake. The altitude (4,500 feet) and conditions of peach growing are about the same.

The successful fruit culturist of any country must study and practice the conditions precedent to success in his own locality. At all points where water is at command and soil appropriate small fruits succeed, and as a rule tree fruits are equally a success where proper selections as to kinds are made. The greatest bar to success in Colorado is our May frosts. Early bloomers as a rule should be avoided. The crab family of apples are more uncertain than standards, on account of precocious blooming. In my observations in fruit culture in Colorado, I have been most interested in apple and pear culture.

I have noted about two hundred varieties of apples and thirty-one of pears. I here make a note. As a rule I know of no country that will grow and mature good wheat and a Hubbard squash that will not make a good apple country. If this notation be true, as applied to Colorado, then has the possibility of apple culture from the extreme northern to the southern line been established beyond any doubt.

The apple is the king of fruits and numbers more kinds than any other known fruit—probably 3,000.

In a majority of the orchards of the State that I have seen trees are not more than fifteen feet apart, and some even twelve. I have not met a man whose orchard is ten years old and twelve feet apart, but would prefer thirty. In this connection there is another error to be regretted, and that is to encumber an apple orchard with small fruits, such as currants, gooseberries, blackberries and raspberries. The ground should be dedicated to trees alone and they not closer than thirty by thirty feet.

My orchard grounds contain ten acres in a square farm. I have planted as a wind-break black locust thirty feet apart on the outer line of the grounds. On the North and West lines I have set, fifteen feet apart, three varieties of the best native plums I could get. The line of plum trees alternate the space between the locust trees, and set so as to give fifteen feet to the first row of apple trees. The habits of growth of the locust and plum trees are low-headed, and for this reason I conclude will make a good wind-break. This arrangement leaves space for setting twenty-one rows thirty feet apart running East and West, and twenty rows North and South, aggregating 443 apple trees. I have made my selection of trees so as to give me a succession of fruit the year round of winter, fall and summer varieties. As the most profitable kinds I note them in the following order: Winter long keepers, first; fall, second; and summer, third. In locating my trees I have arranged so as to have the hardier varieties North of the more tender, but in no instance have I named a tree I have not seen bear fruit and do well in Colorado.

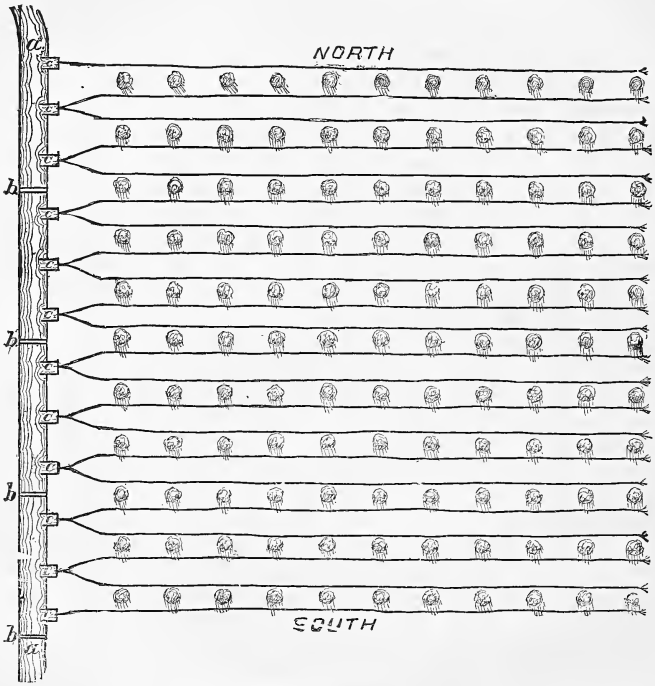
A summary will show my orchard to contain 221 winter trees, 167 fall, 31 summer, aggregating 23 kinds.

I believe success of orchard culture will be best secured by an entire dedication of the ground to growing trees.

To my mind it is somewhat questionable for the best success in orchard culture to grow any kind of crops on orchard grounds, and especially such crops as are exhaustive of plant food. The rootlets of apple trees soon take possession of the orchard grounds. The rootlets of a full grown apple tree are said to extend thirty feet from its trunk, and as a matter of course must be impoverished by the growth of other crops.

Water is the solvent of all vegetable food, and its proper application is a question of paramount importance to orchard culture. Happily for the fruit culturists of Colorado, in most localities you can have water at will, which is an advantage that will discount the contingencies of natural rainfall. Excessive rainfall and scorching drouth are not necessarily

factors in Colorado fruit growing. The questions, how to irrigate and when to irrigate, are questions of deep importance, and I hope will receive a good share of the time of this meeting. With an enlightened practical experience on this water question, a country the proper contour



Orchard Irrigation.
a, canal; *b*, checks in canal; *c*, gates at the head of each row.

which is adapted to the right application of water at will, and living on the direct line of the mean temperature of the North American continent, the Colorado horticulturists have a bright future before them.

THE PLUM.

This fruit is certain to be a success in Colorado, and is each year gaining in popularity. The plum of good quality is always in good demand, and is not only a wholesome fruit, but is profitable when exempt from attacks of insect enemies and the like. On our Gardenside grounds, for several years in succession, plum trees have fruited abundantly. We

Plum tree in bearing at Gardenside.
(From photograph.)

have just been among the plum trees to see the promise of fruit for this season, and find indications most favorable. It succeeds with us both on light, sandy soil and on that which is heavy and compact.

The tender Eastern varieties have not been tested here, and probably would not succeed in our northern counties. But the hardier sorts of

Chickesaws and natives (P. Americana) seem quite at home. Of the nearly fifty varieties at Gardenside, all seem to be doing well, but not more than a dozen of these varieties have yet reached the age of fruiting. In addition to the new hardy sorts like Shipper's Pride, Moore's Arctic, Mariana, Ogon, Boton, Prunus Simoni, Wolf, Rollingstone, etc., we are testing seedlings of our own, and many natives of Colorado. Some of the latter are worthy of quite extended trial, and we recommend fruit growers to be on the look-out for these natives, and whenever a promising one is found to give it a trial.

The varieties that have so far fruited heavily in Northern Colorado are Forest Garden, De Soto, Forest Rose, Weaver, Quaker, and, in special localities, Miner and Wild Goose.

The illustration on preceding page shows a plum tree in bearing on our grounds.

A good place for a plum orchard is either within or near by a hen yard, if the curculio is troublesome. Give the trees an abundance of moisture, and keep the soil well enriched. If trees are so heavily loaded as to endanger the limbs, thin out the fruit, and thereby increase the size and improve the quality of that remaining. If several varieties are grown, plant closely, as some are likely to need fertilizing while in bloom. Large, vigorous trees frequently fail to fruit from lack of fertilization. In all localities where the growing season is rather short, always plant the early maturing kinds. Where the plum curculio is troublesome, it may be destroyed or driven off either by spraying the trees with well-diluted coal tar water at two or three different stages of fruit development (from the time it is the size of B shot, until it is perhaps two-thirds grown), or by the use of arsenical poisons, like Paris Green and London Purple, (1) as soon as the buds begin to swell in spring, (2) two weeks after the petals have fallen. Other similar preparations would, doubtless, be effective, but care should be exercised to use at the right time and in the right proportion.

See paper by Prof. Cassiday.

APRICOT, PEACH AND NECTARINE.

These fruits are so similar in character and habits of growth that the same general rules of culture will apply to all. The only important distinction between the apricot and the other two named, is that the former not only has fruit and wood buds mixed on the shoots of one year's

growth, but also has little fruit spurs, like the plum, which may be renewed by shortening. The nectarine is simply classed as a smooth-skinned peach, but is usually rather more delicate and difficult to raise.

The peach and apricot, particularly the hardy varieties of the latter, promise to succeed over wide sections of the West. Some of the Russian varieties at Gardenside, are, at this writing, heavily loaded with fruit buds. The so-called iron-clad peach trees are being tested on our grounds, said to be as hardy as the Ben Davis apple tree. But time is needed to sustain this claim.

For points on the culture of the fruits under this heading readers are referred to the paper of C. W. Steele, Esq., on "Peach and Apricot Culture" and to the notes from Mr. Wade.

PEACH AND APRICOT CULTURE IN MESA COUNTY, COLORADO, BY C. W. STEELE.

Given a suitable climate for the producing of semi-tropical fruits, the water supply under absolute control, a good market, easy of access, and you have the conditions of successful fruit growing to make glad the heart of the horticulturist. The portion of Mesa County adapted to the perfecting of the finer fruits is comprised in the valleys of the Grand River, White Water, Kannah, Roan, and Plateau Creeks.

The first planting of peach trees in what is now Mesa County was in the spring of 1883. These trees bore fruit the next year and abundantly during the season of 1885 and 1886, making three "peach years" in succession. This year (1887) owing to the late severe frosts, peaches have proven a partial failure. Only a few orchards in especially favored localities having fruited.

Such encouragement has been given the fruit growers, that peach and apricot orchards from a few trees to eighty acres in extent are now common, and the Mesa County horticulturist looks forward with confidence to the time when the markets of Colorado will be largely supplied from the orchards of Mesa County.

The best time to plant is a mooted question, but our experience inclines us to favor fall planting, from the first to the middle of November. We have never lost a peach or apricot tree from winter killing, and the trees make a much larger growth the first season than when planted in the spring. But above all we earnestly recommend would-be horticulturists, don't procrastinate, don't wait from fall to spring and spring to fall,

but prepare the ground thoroughly and plant the trees, be it fall or spring; mark the rows eighteen by twenty feet apart, set the tree about three inches deeper than it grew in the nursery, after trimming all broken roots with a sharp knife. Fill in finely pulverized earth around the roots, firm well, making good use of your feet while planting, prune severely and irrigate directly after planting. Give good cultivation. Potatoes or other low growing hoed crops may be grown between the rows, but the branches need the sunlight. The shade of growing corn will injure the trees. We do not usually irrigate during the growing season later than the first week in September, giving the wood a chance to mature, but always irrigate for winter after the middle of November. Among the many desirable varieties for planting we would specially recommend the Crawfords, Arkansas Traveler, Alexander, Foster, Hale's Large, Early York, Old Nixons, Wheatland and Wager. For apricots, Breda, Moorepark and Early Golden. The Russian varieties will no doubt prove desirable in higher altitudes.

Much loss and dissatisfaction is caused by planting inferior varieties, or such as are untrue to name. Buy only from responsible parties. Send your order to some reliable nursery direct (Colorado preferred) or through some party whom you personally know to be trustworthy. One-year-old trees are to be preferred for transplanting. The area of the profitable culture of fruit may be greatly extended, and to the Mesa County horticulturist the future is specially full of promise.

CHERRIES.

The chief points to be regarded in the culture of the cherry are to avoid all conditions that are calculated to force a strong growth, and to plant on sites that will tend to retard development in the spring. Fruit buds are often destroyed by late frosts, when the tree itself is quite hardy. Another difficulty with the cherry tree in the West is bark bursting.

This suggests the desirableness of branching the trees near the ground. In fact this seems to be the better form of growing the cherry tree in all localities subject to severe changes. The bush form is adopted with great success in different parts of Russia, where extremes of temperature are often violent and cold intense. The cherry is one of the leading fruits of that country. We are heading many of our trees near the ground, but testing several varieties in different ways.

Plant, as a rule, on rather light, well-drained soil, and on a North aspect, if available. Water sparingly, and cultivate with a view of inducing a moderate and definite annual growth.

THE PEAR.

Some portions of Colorado seem especially well adapted to the growth of the pear. It will be successful in most localities where the apple thrives, and being of the same genus (although not quite so hardy), requires substantially the same soil and general treatment. In the Northern tier of Counties in Colorado, except in more favored localities, the pear has not yet proven a success, but certain varieties are likely to be found—perhaps among the Russian sorts—that will adapt themselves to our climate.

MISCELLANEOUS.

The quince, mulberry, berberry, etc., are being tested in different parts of Colorado, and some varieties are doing quite well. The Russian mulberry is hardy, and fruits abundantly, but it is not of particular value as a fruit tree.

SMALL FRUITS.

Much that has been said concerning the culture of orchard trees will apply equally to small fruits. For the best results, the ground should be deeply plowed, or spaded and heavily manured. In fact, intense culture is the secret of success with nearly all small fruits. Place the ground, then, in the best possible shape, always keeping in view the importance of convenience in irrigating. If possible, water should be near at hand at time of planting.

Always set this stock, if in any quantity, with a view to horse cultivation, and use the horse freely, too. Spring planting is usually preferred, although excellent results have been secured by fall setting of such fruits as the raspberry, blackberry, currant, and even the strawberry, if not set later than the 10th of September and well cared for. In all cases of fall planting, mulch before winter sets in. Under a complete system of irrigation, with care in performing the work as it should be done, there is no reason why many things may not succeed set at this season of the year.

Small fruits, with scarcely an exception, should have constant and uniform moisture during the period of fruit development. Some kinds will need more than others, and this is true of soils. Once a week, during the fruiting season, would be a fair average, perhaps, with all small fruits, excepting the grape.

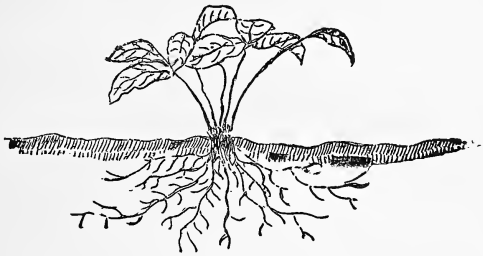
As will be seen by reading the correspondence elsewhere from fruit growers of prominence in our own State, some of them water, after each picking, "their berry vines and plants." This is probably the general rule, and is often necessary; otherwise the crop would be cut short, and the berries deteriorate in size and appearance, if not in flavor. If plants have been well cultivated and heavily mulched, they will require less water, and bear finer fruit, than those neglected in this respect.

The small fruits, like the orchard trees, should be watered late in the season, before they "go into winter quarters," and likewise should not receive much irrigation after September.

If the winter promises to be excessively dry, canes and plants should be covered deeper than otherwise.

STRAWBERRIES.

It is a familiar saying that "the Lord might have made a better fruit than the strawberry, but He never did." By general consent it is the king of small fruits, and prime berries are always in demand at a good figure. Of all small fruits this most delights in rich soil, abundant moisture, and good cultivation of course. The average soil will do if properly enriched, but different varieties are partial to different soils. The Jucunda, for example, is a very indifferent bearer on light, sandy soil, but is hard to beat on soil that is heavy and rich. Some kinds, like the



Well Set Strawberry Plant.

Crescent, Wilson, Cumberland and Manchester, will do well nearly everywhere.

But the general purpose soil that will satisfy reasonably well every variety, is a deep, rich, moist loam, The matted row system is the one in most favor in the West; that is, setting the plants a foot or so apart, with a space of three or three and a half feet between the rows, and letting the plants grow together in, but not between the rows. This gives ample space for cultivating, as well as irrigation. The tendency is for beds set in this way to exhaust themselves early by making too many runners. Hence they should be well supplied with plant food.

The narrow row plan is a good one for most gardeners, but requires more care. In this the rows are two and one-half to three feet apart, with plants one foot from each other in the row and the runners kept off.

There is no doubt that this will produce larger and handsomer berries than those grown in the "matted row."

The "hill system" is setting the plants from three to four feet each way, although practiced largely in the South has not succeeded in other sections of the country for extensive culture.

Be cautious about the use of water in the fruiting season. Keep soil constantly moist but don't soak the beds, and avoid if possible letting water touch the fruit. Mulch well in the early winter, after ground is frozen, with clean straw or coarse litter that is free from weed seed.

RASPBERRIES AND BLACKBERRIES.

Specific directions need not be given for the planting and cultivation of these, as the same general rules will apply to all fruits. We will therefore simply say, have the soil well prepared and properly enriched and reasonably moist. Mark rows the required distance, get good young plants, place them carefully in the ground with roots well spread out and press soil firmly around them. As a rule always let the water follow immediately after planting.

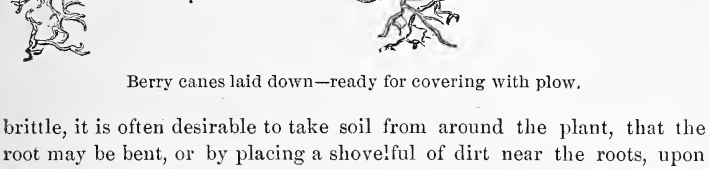
It is advisable, if the spring opens up with drying winds, to irrigate (on light soils), if water can be had, before the canes are uncovered. As winter covering is necessary in many parts of the West, it is well to attend to this early in October.

COVERING.

First cut out all of the dead canes, and those of the present season's growth not wanted for another year, leaving six or eight of the best canes in each hill. It is not necessary to wait until the canes have shed their leaves before covering, as some suppose. They will handle better if not allowed to become too dry. In case the ground is hard and difficult to work, it may be necessary to run water along the rows before attempting to cover. Whenever it can be done, use the plow in covering. Two man can go along the rows and "tie down" the plants, as it is called; that is, one bend down the canes all one way, and as nearly level with the ground as possible without breaking, while the other throws a shovelful or two of dirt on the ends or tips to bind them down, as shown in illustration. After this is accomplished, hitch the horses (sometimes one horse, with light plow, will do) to the plow, and throw a furrow up on the canes from each side of the row. This will rarely complete the covering. It will be

necessary to go over the ground with a shovel and "top off" the hills with more dirt. But the use of the plow greatly facilitates the work, and, in large plantings, saves from one-half to two-thirds the time and expense required by the use of the shovel alone.

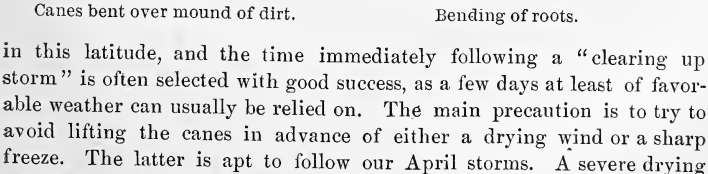
In the case of blackberries, it is important to have the soil quite moist before attempting to lay down the canes. They will not only bend better, but are not so liable to break. With rank growers, inclined to be



Berry canes laid down—ready for covering with plow.

brittle, it is often desirable to take soil from around the plant, that the root may be bent, or by placing a shovelful of dirt near the roots, upon which to lean the cane.

The best time to uncover canes in the spring is something o a mooted question. Occasionally it may be done early in March when a "spell" of pleasant weather will give the tender buds a chance to "harden." After being exposed to mild weather for several days they will be in condition to resist considerable extremes in temperature. The usual date, however, for uncovering, is from the 10th to the 20th of April,



Canes bent over mound of dirt. Bending of roots.

in this latitude, and the time immediately following a "clearing up storm" is often selected with good success, as a few days at least of favorable weather can usually be relied on. The main precaution is to try to avoid lifting the canes in advance of either a drying wind or a sharp freeze. The latter is apt to follow our April storms. A severe drying wind, which is sometimes accompanied by something like a sand storm,

will do more harm at this time of year than all other causes combined. When one of these occurs, if possible to do so, always turn on the water along the rows of berry canes. Some of these days, with an improved signal service, fruit growers may be enabled to avoid the solicitude connected with this phase of small fruit culture. Better still, when a hardier race of fruits shall be grown that will defy the vicissitudes of wind and weather. Still, thanks to the "reserve" buds, our growers have good average crops of these berries one year with another. The depth of soil usually put on the canes in covering is from one and one-half to two inches. It is well to place over this depth an inch or so of coarse manure in the early winter. Some cover to the depth of four inches to retard the growth in the spring.

If summer pruning is done, or "pinching back," as it is called, it should be attended to in May, or early June, when the canes are in full vigor of growth, and at the hight of four and one-half to five feet. This will cause lateral branches to appear that should in turn be pinched back when they have made a growth of one foot or so. The chief aim sought by this is to develop fruit buds by checking the growth of wood. If done at the right time this result may be accomplished. If attempted when the canes have practically made their growth later on, buds, which ought to remain dormant, will be started into a growth that cannot mature before the succeeding winter sets in. For this reason and the additional one, that the practice tends to make the canes stocky, and more difficult to lay down, I have never felt like recommending much summer pruning.

During the hight of the fruiting season the blackberry, raspberry and strawberry should be picked daily, if possible.

The dewberry, or running blackberry, is succeeding admirably in certain localities, and some kinds of this popular fruit are likely to be found adapted to general culture in the West. It is well worth extended trial.

For best varieties see list of fruits given elsewhere.

GRAPES.

Whatever difference may exist among growers as to the "perfect" soil for grapes, or the manner of cultivation and of pruning, it will scarcely be questioned that the climatic influences of this portion of the United States are very favorable both to vine and fruit development. This in connection with the ability to supply moisture whenever needed,

and an abundance of sunshine, comes about as near the ideal condition as could well be named. "Wherever we find the ague an habitual guest with the inhabitants we need not look for healthy grape vines, but high table lands and hillsides, with their dry atmosphere and cool breezes, and on gentle slopes—these are among the best locations for the culture of the grape," says an authority. Again he says: "A good soil for a vineyard should be a dry, calcareous loam, sufficiently deep, (say three feet,) loose and friable, draining itself readily. A sandy, yet moderately rich soil is better adapted to most varieties than heavy clay. New soils, both granite and limestone, made up by nature of decomposed stone and leaf mould, are to be preferred to those that have long been in cultivation, unless these have been put in clover, and rested a few years. If you have such a location and soil, seek no further, ask no chemist to analyze its ingredients, but go at once to preparing the soil."

The chief points to be observed right here are, that all varieties do not succeed equally well on any one soil, nor under the same treatment with respect to irrigation. Neither can the same rules apply, except in a general sense, with reference to pruning. For this reason no discussion of details will here be attempted. All agree that the soil should be deeply plowed or spaded, well drained, with a sponge-like sub-soil that holds moisture well, and should be of a uniform texture and richness so far as possible.

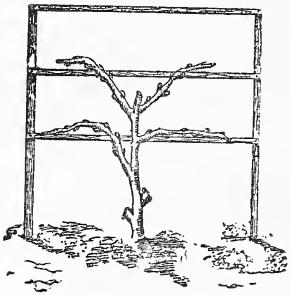
It is safe to say that in all parts of Colorado, barring altitude, soils may be found upon which the grape will thrive. Those localities that seem particularly well adapted to its culture are situations like much of Fremont and Boulder Counties, where the soil is largely of decomposed granite and limestone, and where a modifying influence is exerted on local surroundings by the presence of the foot-hills.

IRRIGATION.

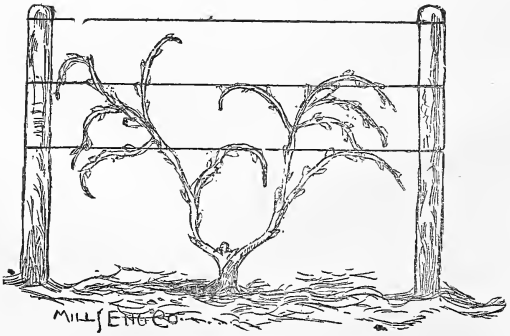
Twice, at most, during fruitage, would meet the requirements of this on some soils; while on the light, sandy soil, with quick drainage (where those kinds inclined to be late in maturing are often planted), once a week might not be excessive. With Concord and Brighton vines on this kind of soil, I have found it necessary to use water freely at this period. It is a mistake to advise the use of little or no water for the grape in our climate, without any regard to the character of the soil and drainage. I say again, that where one application of water might be sufficient on a

Grape Vine pruned for training to perpendicular wires or strips.

One-year Grape Vine pruned.



Three-year-old Grape Vine pruned.



Grape Vine ready for bearing.

site where the roots go down to perpetual moisture (and we know and should encourage this deep-rooting tendency or habit of the grape), a half dozen waterings might be within limits of requirements in another location.

PRUNING.

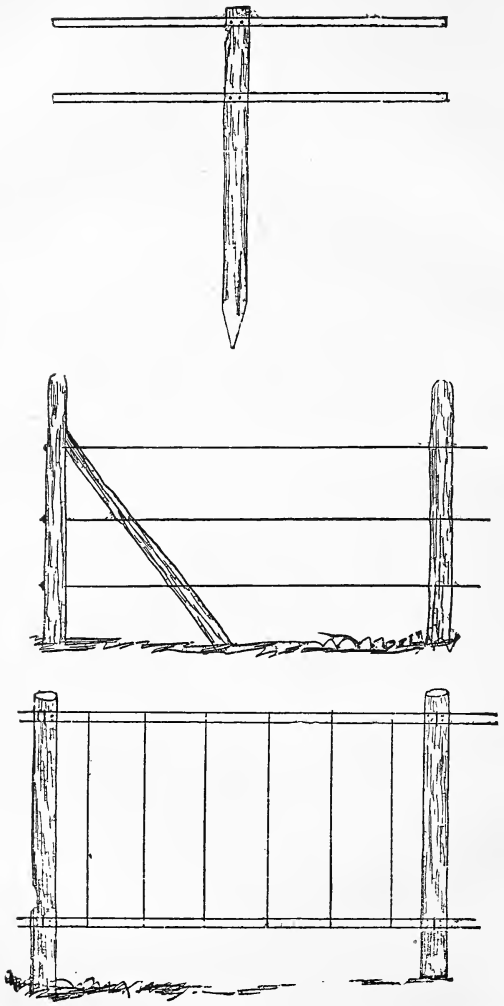
Upon this subject there has been perpetual controversy among growers, and it is not the province of this work to attempt to decide. The proper method or methods, as several are not far from right, can only be learned by experience and careful observation. Our illustrations of the appearance of a well-trained vine, from the planting to its development into full-bearing size, will give an idea of at least one proper method of pruning. This much may be said, that is of universal application: "Avoid too much wood growth." This is always at the expense of fruit, whether of tree or vine. Grow but one cane the first season, and in the fall cut this back to three buds. If the vine has made a vigorous growth, two canes may be permitted to grow the second season, which, in turn, should be cut back to within a few buds of the base. Subsequent pruning will depend upon how the vine is to be trained, also on its habits of growth.

Says the Bushburg Catalogue: "There is one well authenticated fact in the fruiting of the grape, viz: that the finest crops are produced upon the strongest canes of the previous year's growth. The only proper system of pruning, therfore, will be that which encourages and secures an abundance of such shoots."

Mr. Fuller also says: "Some varieties of the strong-growing Labruscas, like the Concord, Hartford, Martha, etc., will fruit best on the laterals of the young canes of last summer's growth, if they have been properly pinched back. All of these rank growers should have plenty to to do—that is, they should be pruned much longer than is generally done. All of the Riparia produce best on spurs of two or three year old canes."

The more tender Labrusca, and all of more or less Vinefera characteristics, like Cassiday, Creveling, Catawba, Delaware, Iona and Rebecca, produce readily and abundantly from the main canes.

Whenever and wherever old bones are at hand, place them where the roots of the grape may feed on them. The phosphates are a staple food of the grape.



Grape Trellises most commonly used. Strips of board may be substituted for the wires shown.

CURRANTS AND GOOSEBERRIES.

A cold, damp, Northern exposure is where nature seems to have planted these and kindred fruits. The *ribes*, in their various species, abound in cool, damp, rich soil and continuous, uniform moisture.

The four essentials to the best results are, high fertilization, annual pruning, heavy mulching and a sufficient stirring of the soil to keep down the weeds and make the ground reasonably mellow. To these, of course, I always add, in ordinary seasons, two or three thorough irrigations during the fruiting time. This latter requirement will depend, however, on the nature of the soil. One can grow many small berries and much wood product, or an abundance of large, fine fruit with little wood.

This much in general terms; now as to details. If any one has any choice in soil or exposure, let that be selected which comes nearest the conditions named. If not, even natural disadvantages may be overcome by good management. In any event, enrich the land generously with good manure—well-rotted stable manure is excellent—plow deep and thoroughly, and place the land in good condition for planting. Mark rows for field culture about five feet each way, or the rows may be five feet apart, and the plants set four feet apart in the rows. My own experience leads me to favor close planting, such, of course, as will not be inconsistent with easy cultivation. It will have a tendency to shade the earth and keep it cool and moist, and to protect the foliage and fruit buds against injury from sun, frost, and extremes of temperature. For garden planting, four feet each way will be about the right thing. After the stock is in the ground, of course, weeds should be kept down, and water, at least the first season, freely applied, without the site is naturally moist. Don't fail to see that there is an abundance of moisture during the time of fruiting. It will greatly aid fruit development in size, yield and general appearance.

PRUNING.

Pruning may be done in the fall, winter and early spring. Late fall is, perhaps, as good a time as as any.

The tree form system of training is neither practicable nor desirable with us for field culture, and should not be practical where the borer is liable to work. A dozen strong branches or root shoots are enough for

any bush. These should be cut back each season, according to the growth made. Where the tendency is to make a rapid wood growth, cut back each season from one-third to one-half the season's growth. This promotes the formation of fruit buds, and, of course, avoids the long, barren stems so often seen in currant bushes. The aim should be to form a compact, stocky bush that will not only yield well, but that will withstand wind and weather. The small shoots or suckers should always be kept down. They are an enemy to the fruit yield.

In pruning, care should be taken not to cut too much of the old wood if fruit is wanted, as the fruit is produced on wood of two years' growth and upwards, and not on shoots of the previous season's growth. Black varieties are, however, an exception to the rule. Their best fruit buds come from the previous season's growth.

We have raised at Gardenside, in one season, on less than an eighth of an acre of bushes, upwards of 800 quarts of currants. When well managed they are a profitable fruit to grow.

CUTTINGS, ETC.

Currants and gooseberries are propagated either from cuttings or layers, usually the former. They grow readily from cuttings which may be made in the fall or spring. If in the fall, where the ground is ready, plant at once, covering close to the terminal bud. Protect them by a mulch of coarse litter or manure. I plant both in fall or spring. Cuttings made in August, if the season's growth is mature, can be planted at once and grown successfully, but the ground should be kept moist and mulched, as stated. They may also be cut in fall or winter, when wood is free from frost, and buried either in cellar or ground outside below the action of the frost, and allowed to remain until ready for planting. In this way they will often form small roots, and be in good shape for making an immediate growth when planted. However, cuttings may be taken as soon as land can be worked in the spring, and, if properly set, they will grow readily. They are usually made in sections of six to ten inches of new wood, and should be cut at the base near a strong bud. The stronger the bud or buds are at the base of the cutting, the stronger will be the roots and growth. Let the soil be mellow and rich, and have the earth very firm around the lower end of the cutting.

Currants and gooseberries belong to the same tribe, or different branches of the same (Ribes) family, and require substantially the same treatment.

Another method of growing both currant, gooseberry and grape cuttings, which is quite successful, is as follows: Cuttings are tied in bundles and buried in a dry place, top-end down, so that the bud end is about one foot below the surface of soil. Plenty of soil must be worked down among the cuttings. Some straw or litter, thrown over the spot, serves to keep the ground from freezing. The soil is removed in early spring to within two inches of the cutting, and a thick layer of fermenting horse manure thrown upon them. This warms the ground, and induces not only rapid callusing, but in many cases formation of roots also. At the proper time the cuttings are taken up and planted in the usual fashion in rich, well-prepared soil.

For currant and gooseberry worm remedies, and for treatment of the borer, see chapter on "Insect Remedies."

CRANBERRY.

It is early yet to state with certainty as to the probability of successful cranberry culture in this region, but the opinion is expressed that those lands impregnated with alkali deposits will not be suited to this fruit. It is more than likely that in the higher mountain ravines, or depressions, which are comparatively free from the action of these salts, and where running water is accessible, lands will be found on which the cranberry will flourish. It succeeds over a wide range of country and does particularly well between 38° and 45° North latitude.

The best soil and situation, says Mr. Thomas in "The American Fruit Culturist," for the cranberry, "consists of peat and muck bottoms coated with pure sand, obtained from adjacent banks, and the ground thus prepared, to be capable of being flooded with clear running water at pleasure during winter, and thoroughly drained at other times. Drift soils have proved unsuccessful. Muddy water over the plants injures them."

The leading cranberries are the Bell, Bugle and Cherry, with intermediate grades.

Another shrub (Viburnum Oxycoccus,) is sometimes classed as high or bush cranberry, and resembles the snowball in wood and foliage. It

succeeds on high lands in various sections of the country and bears red fruit, in appearance some like the cranberry, and while often esteemed, is not generally regarded as a fruit of much merit.

DWARF CHERRY AND JUNEBERRY.

Among the fruits native of Colorado which are worthy of extended planting, and which improve with culture, are the dwarf cherry and the dwarf Juneberry. These are both absolutely hardy, are good annual bearers and quite ornamental in appearance. The fruit of the dwarf cherry is especially valuable for pies and preserves, and is often pleasant to eat from the hand. It is wonderfully productive, and will survive all changes and vicissitudes of the most exacting climate.

The dwarf Juneberry resembles somewhat the huckleberry, but is rather larger; black, with blue bloom, when ripe.

In flavor it is a pleasant sub-acid. Blooms very early in the summer, and is very ornamental at this time. Needs considerable moisture.

SHOWING THE NUMBER OF TREES OR PLANTS PER ACRE WHEN PLANTED AT STATED DISTANCES IN FEET.

	No. of Plants.		No. of Plants.		No. of Plants.
1 x 1	43,560	14 x 14	222	34 x 34	37
1 x 2	21,780	15 x 15	193	35 x 35	35
2 x 2	10,896	16 x 16	170	36 x 36	32
2 x 3	7,260	17 x 17	150	37 x 37	31
2 x 4	5,445	18 x 18	134	38 x 38	30
3 x 3	4,840	19 x 19	120	39 x 39	28
3 x 4	3,630	20 x 20	109	40 x 40	27
3 x 6	2,420	20 x 21	98	41 x 41	26
4 x 4	2,722	22 x 22	90	42 x 42	24
4 x 6	1,820	23 x 23	85	43 x 43	22
4 x 8	1,352	24 x 24	75	44 x 44	22
5 x 5	1,742	25 x 25	69	45 x 45	21
6 x 6	1,210	26 x 26	64	46 x 46	20
6 x 8	910	27 x 27	59	47 x 47	19
7 x 7	888	28 x 28	55	48 x 48	18
8 x 8	680	30 x 30	48	49 x 49	18
9 x 9	537	31 x 31	45	50 x 50	17
10 x 10	435	32 x 32	43		
12 x 12	302	33 x 33	40		

RULE.—Multiply the distance in feet between the rows by the distance the plants are apart in the rows, and the product will be the number of square feet for each plant or hill, which divided into the number of feet in an acre (43,560) will give the number of plants or trees to the acre.

DISTANCES FOR PLANTING.

As to distance for planting no exact rule can be given, on account of difference in habits of growth, but the following table will serve as a general guide:

Standard Apples	18 to 30	feet	apart	each	way.
Dwarf "	8 to 12	"	"	"	"
Standard Pears	12 to 20	"	"	"	"
Dwarf "	8 to 10	"	"	"	"
Plums	8 to 16	"	"	"	"
Cherry Trees	12 to 18	"	"	"	"
Grapes	6 to 10	"	"	"	"
Raspberries and Blackberries	3 to 5 by 5 to 8	"	"	"	"
Currants and Gooseberries	4 to 5	"	"	"	"
Strawberries, Field Culture	1 by 3				
" Garden Culture	1 by 2				

WEIGHTS OF TREES.

Forest trees with clean roots will weigh about as follows: 3 to 4 and 8 inch, 5 to 8 lbs. per thousand; 8 to 15 inch, 10 to 15 lbs. per thousand; 12 to 20 inch, 15 to 30 lbs. per thousand.

One thousand Apple trees, packed for shipment, ordinarily weigh—1 year, 1 to 2 feet, about 400 lbs; 2 years, 3 to 5 feet, 800; 3 years, 4 to 6 feet, 1,400; 4 years, 5 to 7 or 8 feet, 2,200 lbs.

VEGETABLE CULTURE.

The three essentials everywhere to successful vegetable culture are, first, (and at any price,) good seed, true to name; second, good soil; and third, thorough cultivation. To these should be added another condition, scarcely less important, viz: moisture, at all times when needed. The last named requirement is what gives the gardener who has water, or facilities for irrigation, an immense advantage over one who has not.

As to the matter of detail, the first and very important point to be observed is to have the ground in a suitable condition for the crop to be raised. This with reference to culture under the ordinary methods of irrigation, means not only putting the soil in the right shape, but it implies as well having the land graded, so that water can be readily run to any part desired. This, to the grower of vegetables by means of artificial irrigation, is a very important item, and if neglected will be the source of much annoyance and trouble later on. First, then, prepare the ground thoroughly before planting.

The scope of this work will not admit of giving instructions in detail, and with the exception of the chapter on "Celery Culture" we are necessarily limited to brief comments on the leading and best known products under this head. It may be said, however, that many or nearly all familiar varieties do exceedingly well in this portion of the West, and as a rule are profitable for the grower. For valuable information connected with this subject I am indebted to my neighbor, Mr. C. E. Ward, a practical and skillful commercial gardener of large experience.

ASPARAGUS.

This is always a good crop and very desirable. It can be grown either from seed or roots. It requires about four years to get a good stand from seed, hence it is considered better to plant roots. One-year plants are probably best, although two-year plants are often set. In preparing ground manure heavily and sub-soil, if possible.

For family use plant say one foot each way; but for garden culture plant four feet from row to row, and two feet apart in the row.

In setting an asparagus plant set roots exactly two inches under surface and spread the roots out well. The first season cultivate well; keep clear of weeds and irrigate say every two weeks. The second season little may be cut, but not much. The third season the bed comes into full bearing. Each fall put on a good coating of well-rotted manure, and the following spring dig this in and around the roots with a digging fork. After this, a barrel of salt to the acre sowed over the bed is beneficial. This, even if it has no special value as a fertilizer, is often an excellent conserver of moisture.

Keep well watered during the cutting season. After this, water once a month. Cut every day.

BEETS.

Sow from March 15th to April 15th, with Matthews' or other good drill, in rows from sixteen to eighteen inches apart, in rich garden soil, and about one inch deep.

For first early, the Egyptian is excellent; Eclipse nearly as early, and of fine quality—an abundant bearer.

Blood turnip still later; very desirable.

Plant Mangel-Wurzels for stock beet. This is a wonderful yielder, and valuable for stock. Will easily produce 25 tons to the acre.

Never irrigate the beet, unless it is absolutely necessary to bring it up, but cultivate often and well.

TURNIP, PARSNIP AND CARROT.

Sow turnip, parsnip and carrot seed one-half inch deep, same distance as beet, and give same cultivation, with frequent irrigations until the root is fully formed. After carrot or parsnip form roots, or the plants are large enough to shade the ground, do not irrigate them, as it will be an injury, and tend to rot them in the ground. The carrot, especially, is a prodigious yielder, and with good soil and cultivation has been grown in Greeley at the rate of a thousand bushels to the acre. The Danvers variety is an excellent general-purpose carrot.

CABBAGE.

One of the best vegetable crops, when grown on a large scale—say from five to twenty-five acres.

The plant is hardy, and can be set quite early. Has stood twenty degrees below freezing. Plant early varieties in rows two feet apart, by

eighteen inches in the row; and for late kinds, rows three feet apart and two feet in row. One active man, who is familiar with the work, can set, with dibble, ten thousand plants in a day, with a boy to drop plants. They should have good garden soil, but do especially well where very coarse manure has been spread and plowed under. Mark rows the distance to be planted, and, if ground is very dry, run water along in the row before planting; but, in this case, it is better to wait until the soil is somewhat dried before setting. Irrigate immediately after plants are set. In other words, let the water follow the planter right along the rows. As soon as soil is sufficiently dry, put on cultivator. Water again the second day, and afterwards two or three times during the season. Give a little irrigation as heads are beginning to form, but not after they are developed, as this will cause them to burst.

The best early variety is the Jersey Wakefield (Henderson's strain), and the next best, probably, is the Early Winningstadt. For late cabbage, the Flat Dutch has no superior. The Excelsior, of recent introduction, is very fine. The largest variety known is the Marblehead Mammoth. Of 8,000 heads grown by our near neighbor, the average weight was fifteen pounds each. Several weighed upwards of forty pounds each.

Cultivate every week, and until the horse cannot walk between the rows.

STORING CABBAGE.

An important item is winter storage. Prices are usually much better in the spring. Quite a successful way of burying in winter (and this should be done before any very hard freezes), is to open up a hollow trench by throwing two furrows in opposite directions. Then place the cabbage head down, slightly sloping, and lay the next one in same position, or perhaps a little sideways, letting the lower end lap over the head of the other, and so on to the length of the trench. After all are in, turn the furrows back from each side upon the plants. This will leave the covering of earth loose on top of the cabbage for ventilation, and enable the moisture given off by them to escape readily through the porous soil. Before the coldest weather sets in, throw more dirt loosely over the top. Deep covering is very apt to rot the cabbage, especially where the earth is moist or compact. The average yield of cabbages, on good garden soil, should be 50,000 pounds to the acre. From eight acres this season, a

neighbor, Mr. Keever, of Greeley, took off twelve car-loads, netting him $1,200. The average price in Colorado is from 75 cents to $1.00 per one hundred pounds.

CAULIFLOWER.

This plant may be grown to perfection in Colorado.

The early, medium and late varieties will all mature. This is a great advantage over the Eastern States.

Plants should not be set until the weather is settled, which in this section is about the middle of April. This is about the only garden plant that moisture does not injure. In fact it must be kept continually moist and growing right along. If allowed to become stunted or frosted, little heads or buttons will form and the crop is worthless. With the exception of more water, cauliflower requires the same soil, distance in planting and general culture as cabbages.

Henderson's Snow Ball is considered about the best variety. Our Greeley florist, Mr. Leavy, two years since grew two heads of this variety weighing, when trimmed, twenty-six pounds, and was awarded the prize offered by Peter Henderson for the largest and best two heads grown in this country.

Seed is very expensive, and has often cost $8.00 per ounce, but is now reduced. So far it has not been grown in America, but a New Jersey man claims to have discovered the secret, and if so prices will probably be lower.

MELONS.

Musk or sugar melons are a great success with good treatment, but ordinarily most varieties are too late for this region.

Plant in moderately good soil, rather light and sandy, on the level ground and not on raised beds, four feet apart each way. Leave two or three plants in a hill.

After the fruit is about the size of a teacup, pull off all of the small fruit and trim vines back to within six inches of the melons selected to remain. By this means the melons will mature much earlier and will be larger and finer in quality. Give but little water, and as a rule, none after the fruit is half grown.

Water-melons require substantially the same treatment—perhaps a little more water.

Plant cucumbers on good soil and give them lots of water. They are large yielders.

ONIONS.

Our market gardeners report an occasional yield of this garden product at the rate of a thousand bushels to the acre, but with an average of from five to six hundred bushels. Onions are nearly always in good demand with price not less than $1.25 per hundred pounds.

No vegetable requires more careful treatment with regard to irrigation. If not applied at the right time and in the right manner, injury is sure to follow. In irrigating, water should never touch the plant, as it is pretty certain to ruin it in any stage of growth. To avoid this it is best to sow in ridges.

Sow seed with drill from March 15th to April 1st.

Plant two rows, six inches apart, on each ridge, with the ridges two feet apart, using at the rate of four pounds of seed to the acre, on rich ground. Give extra good cultivation. Scullions are numerous among onions, some seasons—probably the result of improper irrigation or poor seed, or perhaps both. Good sets, as well as seed, can be grown in Colorado. For sets, sow seed thickly, twenty-five or thirty pounds to the acre. When up, and bulb begins to form, no more water should be given them. This is a very important precaution, and one of the essentials of growing good sets. After sets are grown plant them instead of the seed, and the crop will not only be much surer, but will be ready for market nearly two months in advance of seed-grown onions.

The best variety for Colorado is the Red Wethersfield and is really a good onion, but its color is against it for market. Yellow Globe Danvers is the best market variety for this section.

PEAS.

All of this family of vegetables thrive under irrigation and should have plenty of moisture during the growing season—particularly at the period of blooming.

The Little Gem and American Wonder are perhaps the best for a summer crop; the Champion of England for later. The latter is called the best "hot weather" pea.

Plant in drills three feet from row to row.

RADISH.

This is a very popular relish and is always in great demand. A rich sandy loam is best for its cultivation and successful raising. The first crop, out doors, is usually planted from the middle of March to the first of April.

Wood's Early Frame and Long Scarlet Short Top, for early.

For general summer crop the Early Round Dark Red. For fall and winter crop grow the Chinese Rose. Red varieties sell best.

Plant in rows sixteen to eighteen inches apart, and give abundance of water at all stages of growth; this causes a quick growth and makes them sweet, brittle and tender. Keep the ground moist all the time. The richer the soil, the quicker and better the growth; this is essential. Keep the soil thoroughly stirred.

SQUASH.

This is not only a delicious and wholesome food for the table, but is valuable for stock feeding, especially for swine. They are exceedingly fond of squash, and will thrive and fatten on it, either cooked or uncooked. Fed in connection with a little corn, or, better still, corn meal, it makes a prime article of pork.

This vegetable will thrive on almost any soil, although, of course, it will do best on good land.

Like the melon family, it needs but little water, and often none at all.

Difficulty is sometimes experienced, in this latitude, in getting the squash fully matured; so, where the tendency is to a great growth of vine, the same treatment should be given as described in growing melons.

Under even fair conditions the yield is enormous, and is always a profitable crop for the gardener and stock farmer.

The Early Orange, sent out for testing last season by the "Rural New Yorker," is a fine summer variety. The Hubbard is the best keeper. Marblehead is rather late in maturing for Northern sections. The Mammoth Chili is largest, and is often grown to the size of 150 pounds; used mostly for stock.

SWEET POTATOES.

This vegetable is well adapted to the dry climate and constant sunshine of Colorado. Excellent yields, with fine quality, have been had

in various parts of the State. In one instance in Greeley, at the rate of 600 bushels to the acre were grown, and sold at five cents per pound, wholesale.

Set the plants in rich, sandy loam, on ridges thrown up by one-horse plow, three feet apart and sixteen inches from plant to plant.

Run water between ridges and let it soak up, but put no water on the plant, as it will cause sun-scald. Give about the same water as to Irish potatoes; but after the tubers are thoroughly set, give no more water.

Keep vines from taking root at the joint.

After digging, allow them to remain in the sun a day, and they will be sweeter and less watery.

Red Bermuda is one of the best sorts for Colorado.

STRING BEANS.

This is another great vegetable for a climate and soil like that of Colorado. "Can almost beat the world on these," says a gardener. With good, rich soil, rather sandy, and an irrigation once a week, the result will be astonishing.

The Golden Wax is the earliest, best and most profitable, and a most delicious table bean.

Plant rows two and one-half feet apart, in drills.

SWEET CORN.

The point to be observed, in the cultivation of corn, is to water at the right time, or the crop will be injured. It needs but little irrigation (none, as the rule,) until the tassel is on, and again when the ears begin to form. One irrigation will often do.

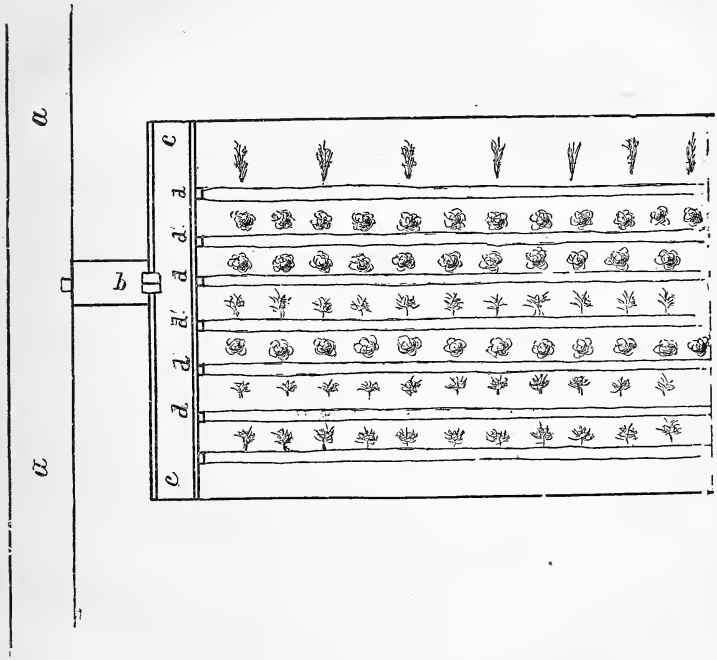
The Minnesota for first early, and Stowell's Evergreen for fall, are among the best for general crop; but both should be planted at nearly the same time, in order to get the proper succession.

TOMATOES.

Not safe to set out, in Northern Colorado, until the middle of May.

For general crop, the Acme and Livingstone's Perfection are perhaps the best. Plant on rather poor soil, and without manure. Set in rows six feet apart, with plants three feet apart in rows. Between the rows, a row of early sweet corn may be planted. This will furnish a shade for

the plants, and not interfere with their growth. The ground for tomatoes should be thoroughly soaked immediately after they are set out, and perhaps irrigated again in a week or so, but should seldom be watered after the fruit has set on the vines. Good cultivation will develop the fruit best.



Neat Method of Garden Irrigation.
a, canal; *b*, flume; *c*, box or pipe at head of rows; *d*, gates or checks at head of each row.

This is usually a profitable crop, but is sometimes troubled with blight, which is attributed by some to the injudicious use of water, or unfavorable soil.

Alkali land should not be used for tomatoes. Our neighbor, Mr. Ward, took last season, from 640 hills, 622 bushels of ripe fruit, and left upwards of 40 bushels of immature fruit unpicked; so that this strip of ground netted him nearly $200.

RHUBARB OR PIE PLANT.

This is a plant that well repays cultivation and requires less care after it becomes established than most vegetable roots. Little irrigation is needed, and often none, if soil is deep and mellow and liberal mulching is practiced. It is a good plan to throw around each hill, in the winter or early spring a liberal coating of well rotted manure; hen manure well mixed with soil is excellent.

If desired for early market, a rich sandy loam is best, and the growth may be hastened in the spring by placing around the plants a half barrel with bottom out, or any similar arrangement. Give the plants plenty of room—three feet square for each will not be too much.

The varieties generally grown are for early, Linnaeous, and Victoria for late.

HORSE RADISH.

This root is largely grown and is very profitable in some localities, and does well everywhere. Will make a prodigious growth in rich, deep soil. Being a deep-rooting plant little or no irrigation is needed. Should not be planted on soil or in a place that cannot afterwards be deeply plowed or spaded, (that is to be used for other root crops,) because it takes possession of the ground and is difficult to exterminate.

CELERY CULTURE.

BY JOHN TOBIAS, OF JEFFERSON COUNTY, COLORADO.

Since writing upon this subject, some six years ago, celery culture near the city of Denver has taken great strides forward, as far as quantity is concerned. At the present time not only is the home market fully supplied, but it is being shipped to all the large mining towns in Colorado and hundreds of miles in every direction, and in dry years like the last (1887) was shipped to Kansas City and farther East, thanks to our system of irrigation which makes it a safe crop to grow in Colorado.

As far as quality is concerned I can see no improvement in the past five years. The following are the varieties mostly grown, and the merits of each:

At the head of the list and for main crop I would place Golden Dwarf, or Golden Heart of some seed dealers—both the same—as the best for winter use.

This variety will grow two feet high and twelve inches in circumference. It will keep longer and better than any other variety I have tried. Perhaps three-fourths of the celery grown for this market is of this variety. White Plume would perhaps come next in quantity grown. This variety is intended for fall and early winter use; is self-blanching to a great extent, the inside stems and tops being of a silvery white color, even without banking up; is very ornamental on the table and is used very extensively for this purpose. Although blanched in appearance it is by no means as brittle and tender as other varieties that require the exclusion of light to blanch them. If earthed up, like other varieties, it would be sweet and crisp as any; but it is not a good variety to keep later than New Years.

The Golden Self-Blanching is a variety introduced lately which is growing in favor with many for early use; is of a short and stocky growth, rarely ever over eighteen inches high, the inside being very short; grows very close and compact; very liable to rot if banked up too high in hot weather—in fact, should not be banked at all. A few inches

of soil around the base of the plant, or the plant tied together low down, is about all it needs to blanch it; even then only the heart of it is fit for use. Have never tried its keeping qualities.

Henderson's Half Dwarf is little used at present and Red Celery not at all, as there is no demand for it. Celeriac, or root celery, is grown in a small way by a few gardeners.

Seed sowing should be done in this latitude about April 1st, in a cold frame or out of doors, in a damp place. If sown much earlier many of the plants will go to seed; if allowed to suffer for want of water they will also throw up seed shoots. The soil of the seed bed should be rich and made very fine, as celery is very slow in sprouting.

Sow thinly in drills two and a half inches apart (if in frame), cover one-fourth of an inch deep; water with a fine rose watering pot, and never allow to get dry until the plants are up, which will be in about three weeks. To save much watering, it is well to cover the ground with burlap sacks or material of that kind, removing them when the plants appear. If glass is used, shade it from the hot sunshine. If sown out of doors, it should be where they will not suffer for moisture. Drill in rows a foot apart, so they can be cultivated and hoed; or, the seed may be drilled in where the plants are to remain, being afterwards thinned to the required distance. This plan saves some work in transplanting. If the seed was sown carefully in the seed bed, the plants will need no thinning. With good seed, four to an inch will be about right. One ounce of seed should sow a bed of eight square yards; two ounces will give plants enough for an acre of celery. When about two inches high, if found to be too thick, they should be thinned to the required distance, being an inch apart, if it is not designed to transplant them before permanent setting; if to be transplanted later into another bed, then about four to the inch. When about four inches high, cut the tops off about midway, and, if inclined to grow long and spindling, cut them off once or twice again. About the 1st of June, if the plants have been left thick in the seed bed, they should be transplanted into another similar bed, about three inches between plants each way, well watered and shaded for a few days, until they have started to grow. If the plants were thinned in the seed bed, when small, to an inch or more apart, transplanting will be unnecessary. About a month before it is time to take up, draw a knife along the row, so as to cut off the tap root about two inches below the surface. Give the plants a good dusting of bone dust, which the water will wash down to the

roots, and they will soon form a mass of fine roots near the surface. By this treatment, the plants will be half an inch thick by July 1st. Forcing by heat is not good for them. Celery is a salt water plant, and delights in moisture, rich soil, and partial shade, at least for the plants, if grown under glass.

PREPARATION OF THE GROUND.

The ground, previous to setting out, should be heavily manured a year or more before planting the celery, for best results; plow deep, and harrow until in good condition. A soil that is rather damp, but not wet —that would be good for late cabbages—but slightly too wet for most garden crops; a spot approaching an alkali bed (of which we have plenty in Colorado), but not showing much alkali itself; a heavy loam, rather than sand; such a soil will generally raise good celery, if rich enough. If manure is not plenty, good celery can be raised by making a deep plow furrow where the celery row is to be, and spreading three inches of rotted manure in it, mixing it well with the soil with cultivator or hoe; but it is best to manure the whole ground, as celery roots extend for three or four feet on each side. I would advise against the use of much fresh horse manure, as I think it has a tendency to cause a rank growth, making the celery soft and spongy.

TIME AND MANNER OF SETTING PLANTS.

Early celery, such as White Plume and Golden Self-Blanching, are set out from the 15th of June to the 1st of July. They may be set in rows three feet apart, if not to be banked much; otherwise, four to four and a half feet by six inches apart in the row, if for single rows, or ten inches in double rows, set alternately, the two rows about a foot apart. Set as you would cabbage plants, a few inches below the general level of the soil, but set the plant no deeper than it was before, while standing in the seed bed. Have the irrigating water to follow closely after the planter.

The later kinds of celery require five to six feet between the rows, to give soil and room for banking. Plant the same distance in the row as the other kinds, from July 1st to 10th. Care should be used in removing the plants from the seed bed, that as many roots as possible may be retained. The plants should be graded as to size, not planting large and small plants together. My experience teaches me not to depend upon

rainy weather in which to set celery plants in Colorado. Unless we are assured of two or three days of wet weather to follow, it is best to irrigate them as they are planted. It is also well to irrigate again soon after planting, to make sure of a good stand. I would not advise replanting, unless done in a few days after the original planting.

The treatment from this time on consists in good cultivation, and watering as often as may be necessary, according to the character of the soil, hoeing around the plants and keeping the soil mellow. It is well, after the plants get well started, to fill up the inequalities around the plants with soil, so that they may grow more upright and not spread out flat upon the ground.

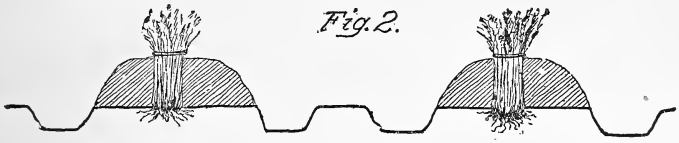
This treatment for two months will bring us to the time of "handling," as it is called, which consists in taking the celery (which should stand a foot or more high by this time), with all the stems gathered to-

Manner of Tying.

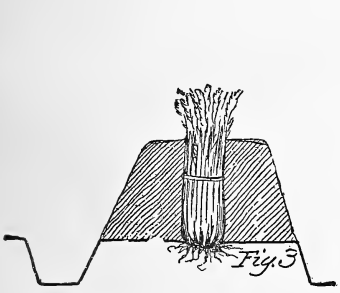
Celery Plant.

gether in one hand, and drawing enough soil around it with the other hand to keep it in an upright position. My own plan—and, of late years, that of many others—has been, after gathering the stems of the plant together and holding them with one hand, with the other hand I place a string around it and tie it rather loosely, allowing for future growth; tie about half way of the length of the plant (see illustration). After a row has been tied in this way, take a horse and small turning plow and turn a furrow against the row of celery from each side. For celery to use early, tie a piece of wrapping paper, eight inches high, around the plant to keep the soil away from it. This is not necessary unless you desire to

raise some extra nice celery, entirely free from rust, as the soil coming in contact with the plant so long is one cause of rust. This is all the White Plume and Self-Blanching kinds of celery will need. It will be ready for use or market in six or eight weeks after this work is done. Handling is all that winter celery will need, provided it is put in trench by October 20th; in which case it should be handled about a month before that time. But, as a general thing, celery, for use about Christmas, is handled about September 15th, left growing two weeks or more, and then banked with the spade as high as the stems go without the leaves. After another two



First Banking.



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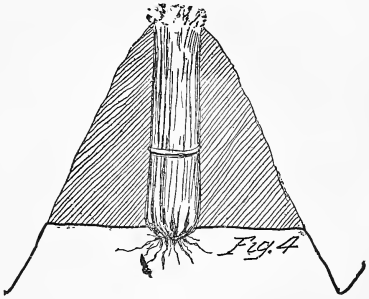
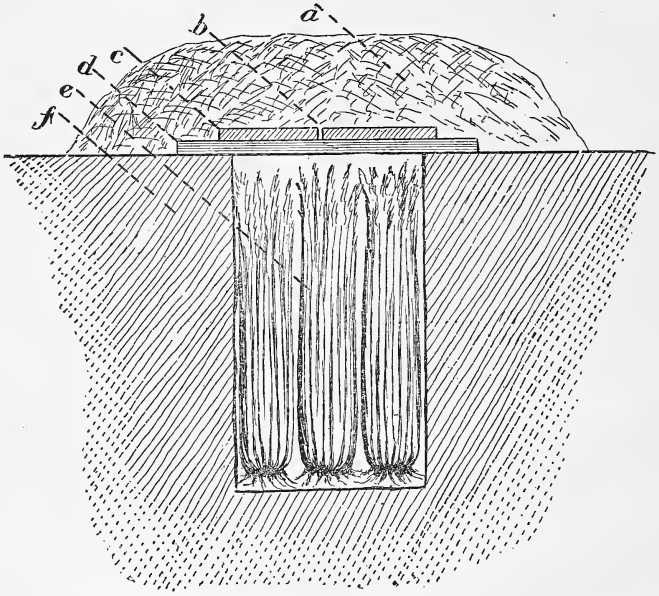


Third Banking.

or three weeks' growth, it will be ready to bank up higher, this time putting the soil clear to the top of the celery (see figures), but being careful each time to keep the soil from getting into the celery. Never handle or put soil to celery when the ground is wet or frosted. It can be left after the last banking until it is time to trench it; or it may be left out until ready for use, by putting enough soil or coarse manure around it to keep out the frost. Left in this way, it will be ready for market the latter part of November.

The time for storing or trenching for winter is from October 20th to November 10th. That which is hilled up the highest can be left out the longest. A light freeze will not hurt it providing you do not touch it. Celery will stand nearly as much freezing as cabbage. Dig your trenches a few inches deeper than the celery is tall, including a few inches of roots, and not more than ten or twelve inches wide. If the soil is damp or wet on the bottom, provided no water stands in it long, all the better.



Storing Celery.

With a horse and plow work down the soil from around the celery. With a sharp shovel take up the plants, with a few inches of root attached, place in the trench upright, rather close together without crowding; cover with boards held up with cross-pieces a few inches above the tops of the celery, so as to leave an air space over the trench and under the boards. A few inches of straw upon the boards is all that is necessary for some time, or

until cold weather. When it threatens to freeze up be prepared to put on more covering of long, coarse manure, six to twelve inches deep, or enough to keep out frost. But it is best to delay putting on heavy covering as late as it is safe. More celery is spoiled in the trench by heating than by freezing; so, after a heavy covering is on it will require airing every fine day, during the winter, by opening a small hole in the cover about every rod.

In preparing celery for market the outside green leaves and the roots are removed, all soil washed or scrubbed off and any decayed or rusty spots neatly removed with a sharp knife, assorted as to size and tied in bundles of twelve stocks. If it is to be shipped any distance, each bundle should be wrapped in brown wrapping paper.

The cost of raising celery, per acre, is about as follows:

Interest on $300 at 8 per cent	$ 24.00
Manure, forty loads at $2.00	80.00
Plowing, harrowing and marking—one man and team	3.00
Planting—one man four days at $1.50	6.00
Cultivation—one man and horse three days at $2.00	6 00
Hoeing twice—one man three days at $1.50	4.50
Handling or tying—one man ten days at $1.50	15.00
Banking—one man fifteen days at $1.50	22.50
Trenching	10.00
Water and watering	7.00
Thirteen thousand plants at $4.00 per thousand	52.00
Preparing for market	30.00
Total	$ 60.00

Prices here range from 25 cents to $1.00 per dozen, according to size and quality; the small being raised at a loss, the large at a good profit. Perhaps a fair average would be 50 cents per dozen. Counting 12,000, or 1,000 dozen per acre, we have receipts of $500.00, or about one-half profit. Where land and manure is high and scarce, it is desirable to help out expenses by raising an early crop upon the ground before the celery is planted, which can be done in Colorado to some extent, but not as well as in the Eastern states where the seasons are longer. Early peas may be planted on the ground, and after the first good picking the whole turned under, when it makes a valuable manure; or early cabbage, cauliflower, beets, turnips, lettuce, or potatoes may be planted in rows six feet apart, and in July the celery set between the rows. The first named crops will be off the ground before it is needed for banking purposes. By this means two crops can be raised, and hence the gardener can well afford to manure the ground heavily.

VITALITY OF SEEDS.

The keeping quality or vitality of seeds will depend somewhat upon the manner in which they are kept, as well as upon the conditions of climate and of planting; but the following is perhaps a fair approximate of the average vitality of the list given:

	Years.		Years.
Artichoke	5 to 6	Pumpkin	8 to 10
Asparagus	2 to 3	Rhubarb	3 to 4
Beans—all kinds	2 to 3	Squash	8 to 10
Beet	3 to 4	Lettuce	3 to 4
Carrot	2 to 3	Melon	8 to 10
Cress	3 to 4	Mustard	3 to 4
Corn kept on the cob	2 to 3	Okra	3 to 4
Cucumber	8 to 10	Spinach	3 to 4
Egg Plant	1 to 2	Tomato	2 to 3
Cauliflower	5 to 6	Turnip	5 to 6
Celery	2 to 3	Pepper	2 to 3
Corn Salad	2 to 3	Radish	4 to 5
Anise	3 to 4	Salsify	2 to 3
Balm	2 to 3	Lavender	2 to 3
Caraway	2	Sweet Marjoram	2 to 3
Hyssop	3 to 4	Summer Savory	1 to 2
Onoin	2 to 3	Sage	2 to 3
Parsley	2 to 3	Thyme	2 to 3
Parsnip	2 to 3	Wormwood	2 to 3
Pea	5 to 6		

THE POTATO.

The potato is one of the leading food staples of this country, the yield in favorable seasons aggregates nearly if not quite 200,000,000 bushels, and Colorado is already becoming noted for the size and excellence of its product of the great tuber.

The soil best adapted to the growth of the crop in Northern Colorado is a good sandy loam, with clayey sub-soil. Early and deep plowing in the spring is recommended, in order to have the land ready to receive and hold the moisture that falls at this season. The best results are obtained by planting from May 15th to June 1st. Some plant sooner than this to secure advantage of the early market, but the yield will be lighter, tubers smaller in size, and the crop uncertain.

The general practice is to use medium and small sized potatoes for planting, and if the seed used is sound and ripe at digging time the small ones will give as good returns as if large seed is used. Cut the large ones twice in two and the small ones once for planting. Avoid cutting seed too small in this dry climate as it is liable to wither and become dried up before it has time to sprout. For the same reason never cut seed many days before planting as it is apt to become dry and worthless.

PLANTING.

The old method is still adhered to by some of furrowing out with plow and dropping by hand. But when a large acreage is to be put in the two-horse planter is generally used. Among the several kinds in use the one that is regarded as among the safest and best is made by fixing a frame on the running gear of a walking cultivator, with a long shoe in front to make the furrow, and two oval shields in the rear to do the covering. By fixing a hopper on top to hold the seed, with a spout down to the furrow, and arranging a lead for the dropper, one man can do the planting as fast as an ordinary team can walk.

Another kind is made in a similar way out of a two-horse corn planter, which will plant two rows at once, but this kind requires two droppers and one driver. Four horses are used abreast and more acres

can be planted than by the first method, but it is more difficult and expensive to operate.

Before beginning to put the seed in mark the ground off in straight rows, from three and one-half to four feet apart. Plant the seed about eighteen inches apart in the rows.

If the ground is weedy it is best to harrow just as the plants are coming up. If they are free from weeds, start the cultivator as soon as the potatoes are well out of the ground and cultivate deep and thoroughly. This will keep the ground loose around the plants and between the rows. If weeds come in so close to the plants that they cannot be covered or rooted out with the cultivator, then it will be necessary to go through with hoes and cut them all out, as a crop of potatoes and weeds cannot be successfully raised at the same time.

IRRIGATION.

All potato growers agree that the longer the vines can be kept growing without irrigation, the better for the crop; but when they begin to wither and turn yellow around the roots, it is time to water them. When this condition is observed, furrow the rows out with the shovel plow with wings attached. Make deep channels so that the water will not run up around the vines, and also arrange so that the lower ends of the rows will not be flooded. This is an important precaution, as permitting the water to flow over on the plants would prove fatal to them. With right management two irrigations are all that is necessary to raise a crop, and frequently one watering will be sufficient if applied at the right time. As soon as the ground becomes dried so that it will not be sticky in working and before it has time to bake, cultivate the soil up loose and deep as before. The crop in Colorado matures usually about October, when it is ready to be dug.

HARVESTING.

No successful potato-digging machine has yet been introduced, but one or two have been tried that do fairly well, and work much faster than by hand if the soil is moderately dry at the time of harvesting. Until these machines are perfected, which they undoubtedly will be in time, the potato fork will be most generally used. Some growers use the plow, but with indifferent success.

If the crop is to be marketed at digging time, the best method is to go along the rows and pick up the merchantable potatoes first, and after-

wards gather the smaller sizes and those to be saved for seed. Sacks should be distributed the entire length of the field, and have the pickers each take a row and work abreast, with one man to shake down the sacks and sew them. This man should see that the pickers do their work well, and not permit them to put in small, scabby or inferior potatoes with those intended for market. Carelessness in this particular will tell when the crop is placed on sale. If they are to be stored, then the best way is to gather all—little and big—and run them into dugouts or cellars made for that purpose, where they can be sorted in the winter time, when labor is much cheaper.

In this way, the yield can be harvested for one-third less than it can be when they are sorted and sacked at digging time. Potatoes will keep well in Colorado through the winter in dugouts, cellars or warehouses, either sacked or loose, with protection against freezing, and with ventilation on mild days. With these precautions they will go through from October to March with from 3½ to 5 per cent. shrinkage, as they scarcely ever rot in this dry climate.

POTATO CELLAR.

Every farmer or potato grower, to any extent, should have a "dug-out" cellar. This can be constructed with little expense, compared with other buildings. A site should be selected near which water will not have to run. Excavations can be done mostly with team and scraper, and should be made to the depth of five or six feet. In dimensions, the cellar should be twice as long as wide, and if the earth is left sloping all around the inside of the excavation, no walling-up will be necessary.

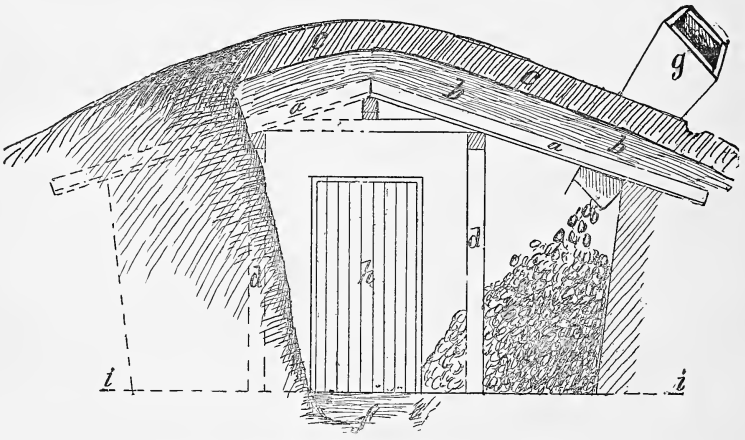
Make wide doors in the south end, and scoop out a run-way for some distance back from the entrance, so that loads can be easily hauled out of the cellar with teams.

Set two rows of posts six by six, eight feet high, about eight feet apart lengthwise of the cellar, and one-third distance from each side put stringers on top, running lengthwise. For rafters, large sized poles or small logs may be used, placing them the same distances apart across the top, from one bent to another. Cover first with boards, then straw, after which place a foot or so of dirt on top. Before the roof is completed, spouts should be placed along each side, say ten feet apart, which will secure ventilation, and also to use in shooting the potatoes into the cellar.*

*NOTE—The illustration only shows the shoot on one side.

These spouts are usually made of boards. The accompanying illustration will show front elevation of the cellar and its appearance when completed. The cost of one thirty by sixty feet would be about $150. When ready to move or market the potatoes, back the wagon down into the cellar by hand, and haul the load out with teams. This will save the labor of carrying them out, a sack at a time, on the back. Cellars are sometimes made with entrances at both ends, so that wagons may be driven in at one door and out at the other, and also so that a team may turn or back around in them.

The best varieties for a general crop around Greeley are the Mammoth Pearl, Rose Seedling, Snow Flake and Early Rose. The Ohio and



Convenient Potato Cellar.
a, boards; *b*, straw; *c*, dirt; *d*, posts running lengthwise of cellar; *h*, door; *g*, shoot and ventilation; *i*, bottom of pit.

Beauty of Hebron do well in special localities. Of the above the Rose Seedling and Mammoth Pearl are the best yielders. The Snow Flake is not as heavy a producer, but is a fine quality and an excellent keeper. Average yield one year with another is, with field culture, one hundred bushels to the acre. This return is often largely exceeded. During the year 1887 two hundred bushels to the acre was not uncommon, and in a few instances even this figure was doubled.

INSECT ENEMIES AND REMEDIES.

BY PROFESSOR JAMES CASSIDAY.

Insects are among the most formidable enemies to the successful culture of orchard and small fruits in Colorado, as elsewhere, and to combat them successfully requires an exact knowledge of their life, history and habits. Irrigating as we do, however, to promote the growth of crops enables us to hold in check some of these pests which in adjoining States prove so injurious to the labors of both farmer and gardener.

Our injurious insects may be divided into two classes, according to the construction of their mouth parts. First, those that eat the structure of plants, and having jaws adapted to this end can only be destroyed through the stomach, by poisoning their favorite food plants. The second class have their mouth parts in the form of a beak by means of which they extract the juices of plants, and hence enfeeble if not destroy them. This class of insects, not eating the structure of plants, can be destroyed only by the direct contact of the remedies applied. Hence the remedies employed are grouped into two classes. First, arsenical poisons, killing insect life through the stomach; the second, represented by alkalies, acids and oil mixtures, are designed to be effective only by direct contact. White hellebore is a vegetable poison and is effective in destroying insect life in both ways. Some insects cannot be combatted successfully by the application of remedies; they must be met by preventive measures, by which the plant is protected from injury, or the known habits of the insects are so circumvented as to render them powerless to do much injury.

Preventive measures are, first, keeping the plants in a thrifty condition. Every observant plant grower will endorse this. Second, a judicious rotation of crops, and fall plowing.

ARSENICAL POISONS.

Paris green is, without doubt, chief among the arsenical compounds, and the most practical for the destruction of insects that eat the structure of plants. If pure it is effective in proportion of one pound to one hundred gallons of water. Where any large number of trees or plants are to

be treated, the liquid in quantity is put in a barrel and drawn on a wagon with a good force pump attached to the barrel. To the pump is attached a hose through which, and a "Nixon Cyclone Nozzle," the liquid is scattered in the form of a finely divided spray.

In spraying trees, a light pole about ten feet in length is attached, by means of which the spray is brought closer to the trees and avoids wetting and inhaling of the poison by the operator.

Arsenical solutions need to be frequently agitated to keep the powder in suspension, and to prevent its settling. The greatest care should be exercised in the handling of poisons that they be not inhaled, nor permitted to come in contact with the skin when broken, nor used on plants soon to be used as food. The mineral should be well mixed and applied with great force to the tree.

White hellebore is a vegetable poison. It kills insect life by contact as well as on being taken into the stomach. It will cause death to persons if taken in any quantity, hence it should be handled with care. It is a standard remedy for the currant worm and the various species of plant lice, which are the bane of plant growers in a dry climate. It is best applied as a liquid, combining one pound of the powder with twenty-five to thirty gallons of water, using the force pump and nozzle as in the case of Paris green.

Kerosene emulsion is without doubt the most effective of all the remedies employed to destroy insects that have mouth parts adapted to sucking the juices of plants, and it is effective only as it comes in contact with their bodies. The best emulsion is that made from the formula used by Dr. Riley, the eminent entomologist. It is as follows:

Kerosene, 2 gallons.
Soap, ½ pound.
Water, 1 gallon.

Heat the water, dissolving the soap in it, and then add it boiling hot to the kerosene. Churn the mixture forcibly by means of a force pump and spray nozzle for five or ten minutes, when the mixture will have assumed a creamy appearance, the globules of oil will have disappeared, and the result is a staple emulsion. Before using, dilute with from nine to fifteen parts of water to one of the emulsion. Good judgment must be exercised in regard to the strength at which it is applied. For if applied at full strength to plants at the beginning of the growing season it will certainly kill them. Later in the season they would stand a stronger dose with impunity.

This remedy is effective against plant lice, the grape and apple leaf hopper, and the climbing cut-worms, occasionally so destructive to useful vegetation in Colorado. It is applied by means of the force pump and nozzle, already spoken of, observing to discharge the fluid with considerable force, so as to produce a very finely divided spray. Fields' force pump is considered the best for this purpose, and the Nixon Cyclone Nozzle the best of its kind.

Birds are valuable aids to the tree grower in the destruction of noxious insects. Where it not for the blackbird, our cottonwoods would be destroyed by the cottonwood beetle. The quantity of eggs and larva of insects destroyed annually by birds is astonishingly large. The blackbird and robin, it is true, are predacious on useful plants, but we could not dispense with their services in ridding us of an excess of injurious insect life. The planting of wind-breaks, shelter-belts and masses of trees and shrubs generally promotes the domestication of birds, in affording them shelter for their nests.

DESTRUCTIVE INSECTS.

Apple Leaf Roller (*Tortrix-rosaeana*).

The larva of this leaf roller is very destructive to the foliage of the apple tree early in the season in Colorado. While it is a general feeder, it is found most commonly upon plants of the family Rosaceæ. Leaf-rolling insects of all kinds may readily be destroyed by the wet mixture of Paris green.

Cabbage Worm (*Peris Rapæ*).

This well-known pest was present in Northern Colorado in the summer of 1887 in large numbers. It was our most common butterfly. It was imported from England, and first appeared in the neighborhood of Quebec in 1859. It has since spread all over the United States. The butterfly is white, with black spots upon its wings. It is two-brooded, the second being the most injurious. The first specimens appeared early in March. Pyrethrum is the most effective remedy of any in use for the destruction of this pest. The powder is best applied by means of a Woodason bellows. An active man should be able to sprinkle two or three acres per day.

Cut-Worms (*Agrotians*).

Several species of these worms are injurious. The moths are dingy in color, and fly mostly at night. The worms generally feed at night; some, however, feed during broad daylight, partially concealed by the dense foliage of the plants attacked. An undetermined species was alarmingly destructive during the summer of 1887, feeding with equal avidity upon the foliage of the herb, and the unripened fruit of the tomato.

For the species that feed at night, the only effective remedy is the one recommended by Dr. Riley, which is to poison with Paris green succulent vegetation, and place on the ground at the base of the plant attacked. As against the species feeding in daytime, the kerosene emulsion is very effective, observing, in the case of plants with very tender foliage, not to apply too strong. Where the cabbage is attacked late in summer, no application of remedies to the foliage will be of the least avail. When clover and alfalfa fields are attacked, a good irrigation is very effective.

The Currant Borer (*Aegeria Tipuliformis*).

This is an imported insect very destructive in Colorado. It also attacks the gooseberry, though less frequently. Its color is blue, with yellow bands, resembling a wasp, but really belonging to a Lepidopterous family of borers. The moths appear in June, laying their eggs upon stems of the current season's growth, near the base of a bud, which soon hatch, the caterpillar soon eating its way to the pith, where it remains a year, emerging the following season as a moth. The yellowish, unthrifty character of the foliage indicates the presence of the borer. The affected stems should be pruned off in the early spring and burned. It is the only effective remedy. The pruning, too, will insure a more thrifty growth, much larger fruit, and of better quality.

The Codling Moth (*Carpocapsa Pomonella*).

This insect is, without doubt, the worst enemy of the apple. It makes its appearance early in spring, about the time the apple trees are in blossom, and commences laying its eggs, usually one on the blossom or calyx end of each apple as soon as the fruit is set. The eggs hatch in from five to ten days, on which the young worm eats its way to the center of the fruit, where it remains twenty to thirty days. It then leaves the apple and seeks some secure hiding place, usually the rough bark of the

tree, where it spins a papery cocoon and passes into the pupa state. It remains in this state from nine to fifteen days, when it comes forth a perfect moth, and proceeds to repeat the cycle of existence just noted. The second brood is also highly injurious. The most of the larva from this brood spin up during late summer and fall, to reappear the following season as a moth. By far the best remedy for this insect is Paris green, in the proportion of a teaspoonful in one pailful of water, observing to stir frequently, and to scatter the water in fine spray on all of the fruit. The poison must be applied when the fruit is about the size of a pea. Two applications will generally be sufficient. Dr. Riley says that Paris green may be used on the fruit of the apple in Colorado without fear of dangerous results to consumers of the fruit so treated.

An application of Paris green, besides destroying the codling moth, is equally effective against the leaf rollers, and other caterpillars which defoliate our trees thus early in the season.

Plant Lice (*Aphididæ.*)

The plant lice are among the most injurious of insect life in a dry, warm climate. Among orchard fruits the plum suffers most. The cabbage and late turnip are also very subject to attack by them. Either the hellebore mixture or the kerosene emulsion will destroy them, diluting the latter in the proportion of one part emulsion to thirteen parts of water.

Owing to the universality of plant lice, and the diffiulty experienced sometimes in destroying them, it is of the greatest importance to keep all growing plants in a thrifty condition. They are about certain to infest plants or trees in an enfeebled condition, so that measures tending to promote thrifty growth will be helpful in warding off their attacks.

Colorado Apple Leaf Beetle (*Graptodosa Foliacea.*)

This beetle and its larva are particularly destructive to young apple trees, and to the grape. As it likes to feed within three or four feet of the ground, it is only injurious to nursery stock or young trees in orchard. It will not feed upon the pear, and it exhibits a preference for thin-leaved varieties of the apple and grape. The Paris green remedy will remove them readily—observing to apply the remedy early, so as to destroy the first brood.*

*Note—Air slacked lime dusted on the foliage, when moist, will often repel this pest —A. E. G.

Raspberry Saw Fly (*Selandria Rubi.*)

The larva of the saw fly are injurious to the rose, the plum and the raspberry. The greenish slugs destroy the pulpy portion of the leaf, feeding on its underside, and are generally present in numbers sufficiently numerous so that the foliage looks as if scorched by fire. One or two applications of the wet mixture of hellebore will be found effective in destroying them.

We follow Professor Cassiday's paper with a few comments on

Fruit Tree Blight.

As there is neither a *certain* known remedy nor preventive for apple and pear tree blight, no attempt will be made to discuss the disease here. Probably the best safeguard that can be adopted is to plant orchards on high, well drained sites, and in soils rich enough to induce a thrifty annual growth. If trees can be protected from sudden extremes of heat and cold and, in fact, from all immoderate or unseasonable changes in temperature, so much the better. It may be stated on general principles that whatever tends to impair the vitality of a tree, renders it more liable to disease of any kind.

While scientific investigations disclose the presence of bacteria in cases of tree blight, it is by no means a settled question that these (*micrococcus amylovorus*) are the true cause. Professors Arthur, of New York, and Burrill, of Illinois, maintain, I believe, that they are, while others are inclined to the view that bacteria are rather an accompaniment or result of a diseased condition.

Sections like Colorado are likely to be much more exempt from the trouble than many portions of the East.

ALFALFA, CHILIAN CLOVER, OR LUCERNE.

(*Medicago Sativa.*)

HISTORICAL.

Alfalfa or Lucerne.

This great perennial forage plant is one of very remote origin, and seems to have held a leading place among grasses from the earliest times. When first known it is said to have flourished in the South of Europe

under its Latin name—*Medicago Sativa.* At a latter period it was called lucerne, which is really its proper modern name, although in Colorado and the West, the Spanish term, alfalfa, is adhered to, as it comes to us from the vast pampas of South America, where this grass grows wild.

Its history has been traced back for more than twenty-five centuries, and writers claim that it was cultivated in Greece five hundred years before the Christian era, and that during the Roman Conquest it found its way to the latter country, where it is cultivated and highly esteemed at the present time. From Rome it is supposed to have been introduced into France and Spain, and subsequently to South America and Mexico. The plant seems to have been brought to California under the name of Chilian clover, at an early period in the history of the State, and from there has been distributed to different points in the United States.

Although cultivated here scarcely more than a dozen years, alfalfa has already taken a leading place in the agricultural economy of Colorado. Its cultivation is increasing by thousands of acres each year, and to-day no one is prepared to say what we would do without it in this State.

Experience has shown that it is specially adapted to the dry climate and perpetual sunshine of this region, and, taken one year with another, is among the safest and most profitable of farm products. When once thoroughly established, it has remarkable vitality, as the roots penetrate the earth to the depth of from ten to twenty feet or even more. It is said that fields of this crop in parts of South America, known to be centuries old, are still in full vigor and productiveness.

SEEDING.

The ground should be prepared for this as for the average farm crop. A rich, deep sandy loam is best adapted to alfalfa, as it is a heavy feeder, and the better the soil the quicker and stronger the growth. Seeding may be done either by sowing broadcast and harrowing in, or by drilling in; the former method is generally practiced, and is usually found to avoid the danger of getting the seed so deep that it may not germinate well. Occasionally, however, good results are secured by drilling in, and only about half the quantity of seed is used that is required in sowing broadcast. But, as remarked, broadcasting is practiced most generally, and, on an average, twenty-five pounds of seed are used to the acre. The more thickly and evenly distributed, the finer and better the quality of the grass. If the stand is thin, the growth is apt to be coarse and woody.

Formerly the practice was to wait until all danger from frost was over, in the spring, before sowing; but now most farmers prefer to sow as early as possible and take the chances of injury from frost (thus securing the benefits of spring moisture), rather than incur the damage apt to result by drouth from too late sowing.

It is important to select good, clean seed, even at a higher price, than to use an inferior article, that is liable to be mixed with noxious weeds and worthless chaff. Oats and barley are sometimes sown with alfalfa, and good results received, where there is sufficient moisture to bring up both crops without irrigation for that purpose. This practice is recommended by some and disapproved by others. On weedy ground it is often advisable to sow with oats or barley.

After the grain is cut, the grass is generally able to protect itself from weeds. Irrigation should follow the cutting of the grain, when the grass will come forward rapidly. If the seed is sown without grain, do not water the young growth (unless it is absolutely necessary to save it from burning up) until a few inches high, because the ground is liable to bake and the tender leaves to sun-scald. If, however, the stand begins to droop and turn yellow, apply the water.

The first season's yield is usually light, but by running over with a mower early, one fair crop may be had the next cutting—four or five weeks later. The second year, nearly, if not quite, a full crop will be secured, which means, as a rule in Colorado, three good cuttings each year. Occasionally a fourth cutting is taken off; but this is apt to be immature, and difficult to cure properly. In portions of California, where there is almost perpetual summer, from eight to ten cuttings are secured annually under irrigation.

Seeding is sometimes done during summer and autumn, and even late in the fall; but this plan is not recommended, except under very favorable conditions, as failures are more likely to result than from spring sowing.

To those in the "rain belt" who propose to sow alfalfa, the chief hope of success will be in selecting the best soil possible, with deep plowing and early sowing. If the roots can once get thoroughly established, a fair crop may be raised without irrigation—under favorable conditions.

IRRIGATION.

The usual practice is to water thoroughly after each cutting; but one should be governed by the conditions of the soil as to moisture. If it is

already moistened deeply, either by reason of heavy rains or seepage water in the sub-soil, this of itself may be sufficient. It not unfrequently happens that the soil is so well moistened from seepage alone as to require scarcely any irrigation.

Water should never be allowed to stand long upon alfalfa, nor to freeze on ground that is seeded to it, as there is danger of killing the roots by want of care in these particulars.

HARVESTING.

Next in importance to having a thick, even stand of grass is the matter of harvesting at the right time. Some experience is needed to determine this point; but the generally accepted rule now is to "cut when the plant is just coming into blossom," and not to wait until it is in full bloom and ready to go to seed. Here is where mistakes are generally made, as it is easy to ruin the cutting by failure either to cut "in the nick of time" or to cure properly; in other words, it means simply the difference between clean, sweet, nutritious and palatable food, and dried-up, woody, innutritious, indigestible, worthless stuff. In this connection I quote from a clear-headed writer (Mr. McNeal), before the Wheat Ridge Farmers' Institute, of Jefferson County, Colorado.

"Alfalfa is valuable in proportion to the quantity of sugar and albumen it contains, which makes it, when properly handled, a sweet and palatable feed for stock. Cut when just coming into bloom, it contains one-third more nutritive properties than when fully ripened, which are lost if allowed to form seed, and makes the hay both innutritious and indigestible. So, if alfalfa is cut at the proper time, the juices are in a condition to thicken and become sufficiently dried, so that little sun will be required to cure to that degree that the hay may be safely placed in the stack, to go through a natural chemical change which gives it its fragrant aroma. Some allow their hay to stand until it is all dried up and nothing but a woody stock remains. When stock are forced to obtain subsistence from such dried-up stuff, it compels them to enter upon a struggle for existence in which they get worsted. Make hay while the sun shines and make it early. Do not wait until all the juices and the sweetness of the plants have been absorbed by the seeds, leaving nothing but poor, dry, chippy, dusty stuff. Start the mower early, cure well, stack properly and carefully, and so have nice, sweet, bright hay, and get the highest price you can for it.

The success of wintering stock depends largely on the character of the hay crop. This may be almost worthless from either of two causes: First, from being injured in the curing; second, from not being cut in season, either of which is alike prejudicial to its quality. There is a medium in the process of curing hay, that acts favorably and avoids any injury that may arise from too little or too much curing. Too little curing is a careless manner of taking hay to the stack before the external moisture is all expelled, and the grass has not had time to wilt properly. Too much curing is allowing it to dry to such an extent as to be hard and brittle, and the leaves are shaken off—which is the sweetest part of alfalfa. Large quantities of hay are spoiled from being hauled a little on the green side, or when a little too moist, and in this condition there is an accumulation of unnatural heating, and subsequent mustiness. It is often injured by being exposed too much to the sun. This not only causes the volatile aroma to escape, but much of the coloring matter also, as is shown in its bleached appearance. The milk and butter produced by feed of this kind will be deficient, alike in color, flavor and quantity. It is one of the most valuable fodder plants in the world, but the present method of curing, by exposure to a hot sun, reduces the crop somewhat in flavor and value. A question for the future is ensilage—that is, storing it when green and watery—thus preserving all the nutritive qualities. This method is meeting with great success in Europe and some parts of the East."

The following instructions about making the hay are given by Mr. Lee, in his catalogue, and are perhaps as good "fair weather" suggestions as can be made.

"In making hay, cut one day, let it lay on the swath and cure all next day, raking up early on the morning of the third; if the sun should not shine clear, a longer time may be required. Never shake it out or turn it in the swath in this country, as it will cure perfectly without it, and the more it is turned and disturbed the more it will lose of its leaves and fine stems. Cock it up immediately after raking, while yet damp with the dew, if possible, and let it cure in the cock from one to three days before stacking."

A good average yield to the acre, per cutting, is from one and one-half to two tons—or from four and one-half to six tons for the season. Some prominent cultivators are now using the third crop for pasturing, instead of cutting it. They turn horses and cattle upon it, (after a heavy

frost has "cured" the juices) and have not only experienced no trouble from pasturing in this way, but claim that it is really the most economical and profitable way of using this cutting, and that it is greatly relished by both horses and cattle.

If it is desired to raise seed only, the original seeding should not be so thick, and the ground should not be irrigated until after the cutting. In any case the seed crop should be saved from the first cutting, and allowed to fully mature before harvesting. Our climate is very favorable for growing an excellent quality of alfalfa seed, and the crop is profitable. The average yield of seed to the acre is from seven to ten bushels, under good treatment. Do not use a horse rake when saving the seed, but bunch with a hay fork. An active man should follow up the mower and remove the cutting as it falls from the machine so that it will be out of the way before another round is made. After the seed has been threshed by a machine used for that purpose, it is better to run it through a fine sieve, as by this means poor, and often harmful seeds, like the Dodder, may be removed.

FEEDING.

The first and second cuttings are usually preferred for horses, and the third for cows. This hay should always be kept dry for feeding, as when wet it becomes heavy and soggy, and hence unsafe as a food, either for horses or cattle.

For milch cows, probably no hay is equal to alfalfa, either for increasing the flow and richness of the milk, or for producing butter of a high quality, color and flavor. But to achieve this desirable result, the hay must be sweet and well-cured. Horses, cattle, sheep, and in fact nearly all domestic animals, will thrive and fatten easily on this hay. For road horses, it is better to feed somewhat sparingly in connection with more concentrated food.

In this place we insert the report of Professor Blount, of the Colorado Agricultural College, just at hand as this article was ready for the press.

"Alfalfa stands at the head of all clovers in nearly all respects. It needs no comment. Its feeding value, and as a hay crop, is excelled by nc other plant. As hay, its value may be seen in the experiments made last year. Four steers were fed one month on it, and one on red clover. They consumed each from 133 to 221 pounds more clover hay per month

than alfalfa, and in no case was the per cent. of gain less in alfalfa months, but considerable more. The fact may be clearly seen in the feeding experiment illustrated in the following table. Three steers were fed four months on alfalfa, clover, chop and roots. They consumed in

Oct. and Dec.	Gain.	Nov. and Jan.	Gain.
2805 lbs. alfalfa.	270 lbs.	3558 lbs. clover.	240 lbs.
558 " chop.		675 " chop.	
1275 " roots.		1830 " roots.	

"Each steer is credited the same amount of chop and roots inasmuch as they were given in limited quantities, but of hay each had all he would eat.

"Taking the hay as a base, the alfalfa made a difference in gain of twenty pounds, and 1,053 pounds less of it was fed, showing clearly its superior value for a feeding plant."

PASTURING.

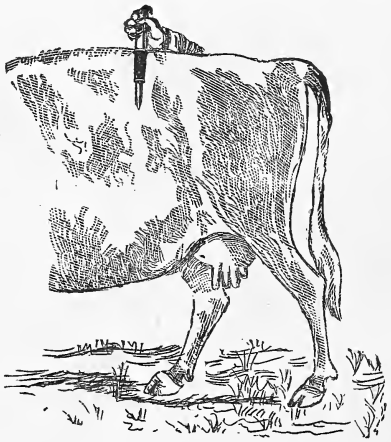
It might as well be conceded once for all that green and growing alfalfa is *never* absolutely safe as a pasturage for cattle. When it is full of juices and immature, they are very fond of it, and are liable to gorge themseves and bloat, if not fed with extreme caution. The greener and more succulent the growth, the greater the danger; and this is always heightened or increased when the grass is wet, either from rains or heavy dews. There is less liability to this trouble, however, on fields that have received little or no irrigation. It is true that there is a difference in animals with respect to this danger or tendency, and the one that eats moderately and rather daintily is usually safe. If the animal is greedy and gorges itself, particularly on an empty stomach, the gasses are pretty certain to accumulate; then look out. The advantages of afternoon pasturing are that the grass is usually dry and the cattle have at least partially satisfied their hunger. But this cannot always be relied on as a guide; nor can the fact that plenty of dry hay has been fed and water given beforehand. All of these "perfect preventives" have occasionally failed to protect. This is the testimony of men of large experience with the grass, and might as well be understood. It is always best to be on the safe side. Neither is salt kept before them a certain safeguard, as some claim, yet it is advisable to do so.*

*NOTE—The following clipping is taken from a leading paper, and we give it for what it is worth. Some of the statements made may be open to question. But if stock can be encouraged to eat clean, bright straw in connection with alfalfa, good

The times when alfalfa may be pastured with comparative safety are, when the growth is fully matured and ready to go to seed (when it has taken on a brownish tinge), and again when frost has checked the growth and cured the juices. Experience has shown that these periods are the ones when there is little hazard in turning in cattle.

Horses are rarely injured, and swine never, by pasturing. Give the porkers free run on alfalfa, and a little corn to "harden" the flesh before they are placed on the block, and the work is complete.

The usual remedies for bloat in cattle are, in mild cases, either to elevate the head and fore-quarters of the animal, by standing it on a stack, manure pile, or the like, when the gasses will often escape; or to



keep the mouth open with a stick or a cob; or give a tablespoonful of hyposulphite of soda; or, in severe cases, use a trochar. The latter is rather a harsh remedy, and should be intelligently performed. Animals are often injured by the unskillful use of the trochar. The rule is to

may possibly result and some harm be avoided: "Many farmers now stack their wheat and barley straw in their alfalfa pastures, and find it of great advantage in fattening their stock, increasing the milk and butter production of their dairy cows, and in every way being an advantage to their health and growing qualities. It is noticed, too, that both horses and cattle will leave alfalfa for days at a time to feed on straw stacks thus placed in the pasture."

plunge the trochar into the region of the greatest distention on the left side, at a point mid-way between the spines of the loins last rib and point of the hip, pointing the trochar in and downward, and letting it pass in obliquely to avoid the kidneys. (See illustration.)

Rumenotomy is the last and most difficult operation for hoven, or bloat, and is resorted to only in desperate cases—when paralysis of the stomach has taken place from engorgement. In this case the contents of the rumen or paunch must be removed by hand. But, as the operation is rarely performed except by skillful practitioners, it is hardly worth while to describe it here.

COMPOSITION OF ALFALFA.

Protein	21.19
Fat	3.04
Nitrogen	36.74
Crude Fibre	29.90
Ash	9.13
	100.00

As a soiling crop, or fertilizer, alfalfa is extremely valuable. Plow it under; and this can be done in fall or early spring, by using four good horses and a suitable plow; and the great roots will decay and enrich the ground almost beyond conception. Some of our Greeley farmers have obtained wonderful crops of potatoes and grain by this practice. In fact, alfalfa does not exhaust the soil, but constantly enriches it. Says Professor Blount: "As a fertilizer it has no superior, if reports from those who have tested it are true. It not only can be turned under, as red clover is, but in the operation it enriches the soil and at the same time is not itself at all impoverished, but greatly benefitted, even so far as to make a good crop itself the same year of hay, and sometimes of seed."

This plant has been known to flourish from sea level to the altitude of seven or eight thousand feet. In favorable surroundings it might succeed even higher up.

A careful consideration of the analysis above given will demonstrate the value of this grass to the farmer in the various uses it can be put. The average price in stack, in Northern Colorado, is six dollars per ton.

An enemy of alfalfa that is troublesome in some localities is the dodder plant (*Cuscuta trifolii.*) It resembles a number of fleshy threads twisted around a branch, and when fully developed is a true parasite, and feeds upon the juices of the alfalfa. It is an annual, and may usually be

destroyed by frequent cutting of the crop infested. Sometimes, however, if thoroughly established, says an authority, "nothing short of digging up the crop infested and burning the whole will get rid of it." But the best plan is to be sure that the seed sown is free from this pest. Alfalfa seed is about two lines long and one and one-fourth wide; while dodder seeds are not more than half the size; hence, if alfalfa or clover seed is well sifted before sowing, the dodder will be easily separated. Here again is another forcible illustration of the importance of obtaining clean, pure seed for sowing.

FORESTRY.

So thoroughly am I impressed with the importance of this branch of horticulture to the best results in fruit growing, that I would be willing to promise a revolution in this industry could I be given the control of the forest tree planting of the Nation for the next twenty years, and the facilities for making the work effective.

I would place a shelter-belt of timber on every farm in the land, and to every tenth acre cultivated, at most, I would have an acre of permanent woods. Furthermore, the most ample precautions would be taken to guard against disastrous forest fires, and to preserve, within reasonable limits, the mountain and native woodlands from denudation. It is doubtful if our Government could make a more judicious investment, or better promote the general welfare, than by annually making well-advised expenditures in the direction of forest tree planting.

The "Timber Culture Act" is founded in a wise public policy, and, if its provisions were honestly carried out, would be very beneficial. But so much neglect and bad faith are shown on the part of many who avail themselves of its generous terms, that the real aim of the law is defeated in a large majority of cases.

It can only be made to accomplish the wholesome objects intended, by the strictest supervision on the part of those in authority. With every reasonable allowance made for failures from unforseen causes or adverse conditions, like lack of water (and these should only operate to extend the time to enable a substantial compliance with the law), no person should be permitted to obtain a title under this act who has not acted, in all respects, with absolute good faith in planting and caring for his "timber claim." If this rule were strictly adhered to, deception would be unavailing, and there would be less heard of the "impossible conditions of the law," or the hardships of enforcing its provisions to the letter, as an excuse for making a farce of tree planting. Let the law stand, and, if necessary, add tenfold to its advantages, as an inducement to planters, but see that the work is done, and done well. Failure is often the result, too, of lack of knowledge of the proper methods of planting, which will be

noticed later on. But the masses manifestly need enlightening with reference to the influence and general benefits of the right distribution of wood lands. That destructive tendencies of many kinds would be arrested if the great West and Northwest could be given the protection afforded by extensive forests, there seems little doubt. It is safe to say that the proper distribution of moisture, the modification of atmospheric and soil temperature, the influence towards preventing the frightful tornadoes, the pitiless blizzards from the far North, and the parching winds that sweep our Western plains, the annual precipitation of moisture, the avoidance of prolonged drouths and of disastrous floods—all these and similar conditions would be most favorably affected. The modifying influences of large bodies of timberland upon climate are too well known to need discussion. For this reason fruit growing is always more certain, other things being equal, contiguous to extensive woods, or where sheltered by trees. As a protection from the disastrous effects of severe winds, they are most valuable to the orchard and garden.

Fifteen years ago the author of "Man and Nature" was of the opinion that not one of our States had, within its borders, with the exception of Oregon, more timber land than it ought permanently to preserve, (meaning of course the relative proportion to the landed area.) Since then the decrease has been considerable, as the annual consumption in the arts alone amounts to over 20,000,000,000 cubic feet.

While the entire forest area of the United States is not far from 500,000,000 acres, (which seems a large amount,) yet our economists agree that we have reached the lowest profitable limit of forest area. Basing the calculation upon the known rates of forest increase in European countries, it is estimated that to supply the yearly demand mentioned, the yield or increase of some 400,000,000 acres must be employed. Add to this the enormous destruction from forest fires, domestic uses, etc., and it will be seen that the conclusion reached from the standpoint of National economies is a reasonable and logical one. But, however indisputable the position taken may be in favor of conserving and adding to the forest area, it is doubtful if the correct solution of the problem will be reached until the people can be made to realize that there is money in the tree as an investment. This it ought not to be difficult to show. Let any person select even one acre of good strong soil, the same as he would expect to grow any profitable crop on, and let him plant say 5,000 small trees of several good varieties—white ash, wild black cherry, black walnut, linden,

maples, for example, or take five acres of any desirable kinds adapted to his section of country. Let these be cultivated and watered say four or five times a year. They may be pruned in the winter time when little or nothing else can be done. At the end of the third year from planting, one-half of these, or a third, might be easily sold for shade or other purpose, if they were nice and smooth trees, at a handsome advance over the original cost and the expense of cultivation. Each year thereafter more than enough can be easily taken, by way of thinning out, to pay all expenses. Now at the end of eight or ten years there should be anywhere from a thousand to fifteen hundred nice, thrifty trees to the acre, and these should be on an average at least five inches in diameter, and from twenty to twenty-five feet high. Here we have then on five acres, say six thousand trees after making due allowance for losses from any cause. Trees of this age of any good hard wood variety are worth for mechanical purposes, at least fifty cents each, and those suitable for transplanting (any good street tree) even at half the size, has always sold readily at that price; and to-day fifty thousand nice street trees—like the elm, box elder and soft maple—from two to four inches in diameter would find quick sale at from twenty-five to fifty cents each at wholesale, (many people in the West will plant nothing but a large tree,) in Colorado and Wyoming. The demand in all this region for years to come will be extensive, and any person who has a well-grown street tree even, need not have difficulty in finding a purchaser.

For mechanical purposes trees like the ash, cherry and black walnut are always in demand wherever they can be got to market. But to return to figures: We have six thousand trees ten years of age worth at least fifty cents each, or $3,000, (and this figure would be low, even on an Eastern basis for some of the varieties,) giving a profit of sixty dollars per acre for the entire time. If nut-bearing trees were set, and they do exceedingly well in portions of Colorado, they should be of producing size by the end of ten years. The estimate on trees so valuable for the arts as some we have named, we believe much too low. These figures are made with some knowledge of results, and are in no sense exaggerated. The serious drawback to tree culture is that people are often unwilling to give trees good soil or even fair treatment. They are too apt to be stuck in the ground and left to take care of themselves. This never pays.

IRRIGATION.

In this dry climate, without the ground is in exceptionally good condition, always follow tree planting by an immediate irrigation. Cultivate several times during the season. Keep down the weeds and water often enough to keep the young trees in active growth. If seedlings are given the right kind of care for the first two seasons they will be well on the way to a fine, permanent growth. If neglected at this period they may either perish or receive a check from which they will never fully recover,

It is usual in Colorado to plant in rows four feet apart, with the trees from one and one-half to two feet in the row—set with a view to thinning out. In this case cultivation can only be done one way. If it is practicable to do so, give a good irrigation once a week during the first season.

Never set young trees on ridges on the plains. They should be planted in a furrow like, so that they may better retain the moisture from the clouds. This is particularly necessary where water is scarce for irrigation. To those in the "rain belt" district who are attempting to grow trees, the importance of deep plowing and setting in trenches or furrows where the soil has been mellowed to a considerable depth, and of early spring planting, can scarcely be overestimated. After the trees have been set, throw around them a heavy mulch or protection of fine straw, chaff, wild hay, or any coarse litter, and it will serve to protect the young trees and retain the moisture that falls on them. In transplanting, we say it again, for the hundreth time, never allow the roots of trees to lay exposed to the hot sun or drying winds.

PLANTING SEEDLINGS.

An expeditious way of setting forest tree seedlings is to run furrows one way with the plow, after the manner described in orchard planting (the ground having been previously deeply broken and well prepared), then let the young trees be placed in an upright position in the furrow the entire length, after which the soil can be thrown back with the plow. It will be necessary to go over the ground and straighten up the seedlings (uncovering any that have been completely covered), and to press the earth firmly against the roots with the foot while passing along. If care is used, the young trees may be fairly well planted in this way, and from three to four may work to advantage in carrying, dropping, and completing the work as the plow is run. But good planting is more likely to be

done by the use of the shovel or spade, and it can be accomplished quite rapidly if properly managed. An excellent method is adopted by Mr. Robert Douglas, probably the most extensive planter of forest trees in the country. Mr. Douglas describes it as follows:

"Before the planting is commenced, the harrow and roller are run over the land, and after that the marker, marking off the ground four feet each way, the same as for corn. The workmen are then divided off into companies of three each, or two men and one boy, the two men with spades, and the boy with a bundle of trees. The two men with spades plant on adjoining rows, the tree-holder standing between them. The planter strikes his spade vertically into the ground on the running line close up to the cross mark, then raises a spadeful of earth, the boy inserts the tree, the earth is replaced, the planter places his foot close up to the stem of the tree—bearing on his full weight—and passes on to the next mark. This tightening of the tree is the most essential part of the work. The boy is kept quite busy attending two planters. After a little experience the boy will learn to bring each tree out of his bundle, with a circular upward motion, that will spread out the roots when placed in the ground about as evenly as they could be placed with the hand. The three persons will plant at least 4,500 trees in a ten-hour day.

When we consider that by this method the trees are planted in a straight line, at a proper depth, the roots spread out, and the earth firmly packed over them, we think it much better than any other method. Dr. Warder named this the "Douglas Three-Motion system," as three motions of the spade are required in planting each tree.

When a great number of men are employed, time is saved by having a man follow in the rear, handing the bundle of trees to the tree-holders. We found that one man could attend thirty to sixty workmen. He would follow with a wagon load of trees close in the rear, and whenever he saw a boy on his last dozen, he would throw him a bundle, the boy would put it under his arm, and use it after he had disposed of the few in his hand. We use a two-horse cultivator among the trees during the summer, and the cultivation is just as simple as for corn. Working up the earth to and from the trees alternately, we use no hoes, as careless workmen will injure a great many trees with this instrument, while horses will rarely injure a tree, and they can be worked so close to the trees that a weed rarely needs to be pulled by hand."

The instruction given for the planting of an orchard, and for the cultivation and irrigation of fruit trees, will in the main apply to forest trees. In the end, it will pay to prepare the ground thoroughly in advance of planting, and to give good cultivation. Right here is where failures are made in most cases. Never make the mistake of setting a tender young tree on sod, nor of sowing or planting seeds in such a place, especially in this dry soil and atmosphere. It is time and money worse than thrown away. For "timber claims" or extensive plantings, a good one or two year old tree is the best.

SEED SOWING.

If seed is to be used, always sow or plant it in rich, mellow soil—if anything, inclined to be sandy—and have it (the soil) well prepared. As a rule, it is better to grow plant seeds on a suitable garden spot, in beds, with rows nine or ten inches apart, and the second or third season transplant to where desired. Select a Northern exposure for the seed bed, or protect with screens of some kind, plant early and do not let the soil bake. Seeds planted in the fall should be well covered with light mulch to keep them from drying out.

Mr. D. S. Grimes writes that he sows thickly in rows in seed bed and shades the first summer. He says: "I drive down stakes, nail on cross-pieces, then take old, refuse gunny-sacks, rip them open and tack them on to the cross-pieces. This covering can be put on quickly and cheaply. In the fall the covering should be removed, to enable the plants to sun-harden. When the plants first appear, care must be taken not to keep them too wet, causing them to 'damp off.' * * * * Seeds of cone-bearing trees require, as a rule, more care in planting. The yellow pine of the Rocky Mountains, however, (*Pinus Pondurosa,*) is an exception, and its seed will grow readily as wheat and more rapidly than any other evergreen. They will make an average growth from the seed of two feet each year. I am sorry to see so few evergreens planted by our farmers."

The depth of sowing seeds depends upon the variety. The rule is, the smaller the seed the less they should be covered. In this dry climate probably one inch would be about right for seeds like ash, maple, elm, etc.* Nut-bearing seeds are planted deeper.

*NOTE—Even deeper planting than this might be required in some instances.

The time for sowing seeds varies with different varieties. The soft maples, (white and scarlet,) cottonwood, linden and elm ripen in early or late summer, and should be sown soon after. The fruit of most nut-bearing trees, and of the plum, apple, pear and peach, should in this climate, either be sown in the fall or kept in moist earth, where they will be subject to the action of the frost in order to secure germination the following spring. Catalpa, birch, ailanthus and some other seeds are generally kept dry in winter and sown in spring. Hard-shelled seed, like the locust and coffee bean, must be soaked in hot water (some say scalded) before planting, and kept warm until they show signs of germinating, when they should be at once planted and not allowed to dry out. Evergreen seeds may be sown in spring, but require careful treatment in seed bed for success. Most of them retain their vitality longer than deciduous seeds. Some of them, like varieties of the pines, have, under favorable conditions, been known to keep for twenty years or more. The silver firs on the contrary should be planted not later than the first season. The beds in which most evergreen seeds are sown should be protected by lath or other suitable screens and well sheltered from the hot sun and drying winds. "The first few months, until the formation of the terminal bud is the most critical time." A close, confined atmosphere with too much water, will be quickly fatal to them. In addition to the screens overhead, mulching the young seedlings in winter with leaves or pine needles is recommended. They may be transplanted after two years and some of the pines at one year. With these, as with all seedlings, weeds should be kept out of the beds.

TRANSPLANTING EVERGREENS.

Colorado evergreens are famous for beauty and hardiness, and among them the blue spruce, (*Picea Pungens,*) is the peer of any in the known world. The Engleman spruce, (*Abies Englemanii,*) the Douglas, (*A. Douglasii,*) the great silver fir, (*A. Grandis,*) and the white spruce, (*Picea Alba,*) are all magnificent trees. In transplanting these evergreens care should be taken never to expose the roots to the sun or air. If possible, always let the dirt or soil adhere to the roots when taking up, and sack at once, with burlap or gunny-sack tied firmly around. Give constant moisture until well established. Where many young trees are to be taken up, and it is not practicable to have earth around them, dipping, or puddling the roots in a kind of a mud batter is sometimes practiced.

The larch or tamarack (*Larix Americana,*) is succeeding well on low, moist soil, or under irrigation. The European species, which is a more valuable tree, promises to be successful and to grow quite rapidly when established. Evergreens may be propagated from cuttings, but to grow this way requires considerable skill and good facilities for controlling heat and moisture.

CUTTINGS.

All species and varieties of the poplar, to which family our cottonwood, (*Populus Monilifera,*) shaking aspen, (*P. Tremuloides,*) and balm of Gilead (*P. Condicans,*) belong, grow rapidly from cuttings if kept in moist soil. This is true of willows and some other trees.

THE CUT LEAVED WEEPING BIRCH.

Among deciduous ornamental trees of great merit for Colorado, special attention is called to the cut-leaved weeping birch. It is a magnificent lawn tree and absolutely hardy in the extreme Northern part o the State.

STOCK FOR GENERAL PLANTING.

The following list of stock for general planting in the West will serve as a guide to those who may wish information in regard to varieties most likely to succeed over widely distributed portions of the country, and under different local conditions. The list might be enlarged somewhat, but the names given are mostly well known, and recognized everywhere as valuable and extremely hardy. One of the most desirable qualities that any tree can possess, for an exacting climate, is that of making a definite annual growth, and of thoroughly maturing this growth each season.

In this connection we emphasize two or three points. It is better to plant but few varieties, except for experimental purposes. Among fruits, the profitable kinds are confined to about three of the leading sorts in the respective classes. Others are more or less doubtful for commercial purposes. The same is substantially true of forest trees. Plant them with a view to a proper succession in season, and set nothing more than can at least be given fair treatment.

Our list, of course, may be added to or departed from, according to local surroundings or the needs of any particular locality.

The usual time for planting in the spring is during the month of April, and in the fall from the 1st of September to the middle of October. As to the distance from each other that trees should be planted, so much depends upon the habits of different trees, that no very definite rule can be given. Those that make an upright, compact growth may be planted nearer together than others whose habits are spreading and vigorous.

See table of distances on page 63.

One word of explanation is proper in this connection. Our list for general planting embraces some well-known varieties like, for example, the Ben Davis apple, which succeeds over a wide region of the West, and which is found, in many States, to be the most profitable winter apple that has been planted. While it is among the hardiest of the old sorts, it could not be relied on to stand the *test* winters of such a climate as North-

ern Iowa, Dakota or Minnesota. For such localities, nothing less hardy han the *Oldenburg* should be planted.

VARIETIES FROM WHICH TO SELECT FOR GENERAL PLANTING.

Apples.

Summer—Oldenburg, Red June, Tetofsky, Yellow Transparent, Red Astrachan.

Fall—Wealthy, Fameuse, Gideon, Haas, September.

Winter—Ben Davis, Walbridge, Talman Sweeting, Scott's Winter, McMahon, Wolf-River, Pewaukee.

New Varieties of Special Merit.

Thaler (Russian), Excelsior (Minnesota), Switzer, Longfield, Antonovka, Hibernial (Russian), Lou, Sweet Pear, Isham Sweet.

Crabs and Hybrids.

Florence, Martha, Whitney, Shields, Brier Sweet, Sweet Russett and Hyslop.

Pears.

Flemish Beauty, Clapp's Favorite, Bartlett. These are probably planted over a wider section of country than any other pears, but the future of pear growing in the extreme Northern portion of Colorado is yet to be determined. Some of the Russian varieties are being tested. Perhaps the most promising of these are the Bessemianka and Gakovaska.

Plums.

For general planting in the West, any one of the following will be found to succeed over a wide range of country: De Soto, Weaver, Forest Garden, Forest Rose, Quaker, Miner and several others of the same type. In favored localities some of the more delicate varieties of the East do well.

Cherries.

Rocky Mountain Dwarf or Low Bush, Utah Red, Early and Late Richmond, English Morello, and Large Montmorency.

The new and especially hardy varieties are Ostheim, Valdimir and Wragg.

Peaches.

(For peach growing sections.) Alexander, Early and Late Crawford, Wheatland and Large Early York.

For severe climates try the Chinese varieties, Peen-To and Tong Pa, and some of the Russian "Iron Clads."

Apricots.

Breda, Morepark and Early Golden, for Southern and Western Colorado, New Mexico, Utah, etc. For Northern Colorado, Western portions of Nebraska and Kansas, Wyoming, etc., plant the Russian varieties, and especially named sorts like Alexander, Budd, Gibb, etc.

Mulberries.

New American, Black and Downing. These are all quite hardy, but will not stand the same extremes of temperature that the Russian red and white fruited varieties do.

Quince.

Orange and Champion. (Not reliable in regions subjected to severe cold.)

Grapes.

White—Lady, Niagara, Martha, Empire State. Red—Delaware, Brighton, Salem. Black—Concord, Worden, Moore's Early.

Raspberries.

Red—Cuthbert, Marlboro, Turner and Clark. Black—Tyler, Gregg, Ohio and Mammoth Cluster. Earhart, (new everbearing,) for trial. Yellow—Caroline, Brinkles' Orange and Golden Queen. Purple—Schaeffer's Colossal. (Should have winter protection nearly everywhere in the West.)

Strawberries.

Cumberland, Crescent, Jucunda (for heavy soil,) Capt. Jack, Manchester, Wilson. New and most promising—Jessie and Bubach.

Blackberries.

Ancient Briton, Kittatinny, Snyder, Wilson.

Dewberries.

(For trial.) The Lucretia and one or two Western varieties of recent introduction.

Currants.

Red Dutch, Cherry, Victoria, Fay's, White Grape, White Dutch, Black Naples, Lee's Prolific, (black,)

Gooseberries.

Downing, Houghton, of American varieties, and White Smith, Crown Bob, and Green Globe of English varieties. Industry, for trial.

Miscellaneous.

Juneberry, Berberry, (red fruited,) both very hardy and ornamental.

For trial in special localities, any of the leading huckleberries and cranberries.

FOREST TREES, ETC.

For timber—White Ash, Wild Black Cherry, Black Walnut, Black Locust, Catalpa (*Speciosa*,) Butternut. White and Red Oak for trial. Test also the Hard Maple. It may succeed in portions of Colorado.

For street trees—Cottonwood (as a pioneer tree on the plains.) Box elder, Soft Maple, White Elm, Linden, White Ash, Black Locust and Balm of Gilead. For trial, Norway Maple, Carolina Poplar and Shaking Poplar.

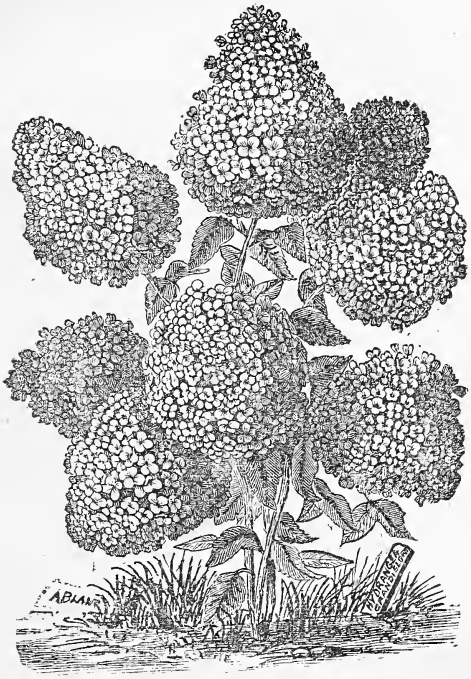
For timber claims—Cottonwood and some other trees of the Poplar family, as a temporary growth. Box Elder, White Ash, Black and Honey Locust, Black Walnut, Butternut, Wild Black Cherry, and for special sections, Hardy Catalpa and Russian Mulberry.

For lawn planting—Cut-Leaved Weeping Birch, Mountain Ash, Green Ash, Hardy Catalpa, Linden. For trial, Poplar Bolleana, Weirs' Cut-Leaved Silver Maple and Laurel Leaf Willow.

Among Evergreens—Plant the native Spruces and Cedars, particularly those of bluish or steel green foliage. The Colorado Blue Spruce (*Picea Pungens*) is an Evergreen of incomparable beauty, and very hardy. The Cedars, with the same silver, frost-like colors, are also very beautiful and graceful.

For wind-breaks—Honey Locust, Russian Mulberry, Gray Willow, Lombardy Poplar and Black Locust.

ORNAMENTAL PLANTS AND SHRUBS.



Hydrangea Grandiflora.

One rule, at least, will apply to the culture of all flowering plants and ornamental shrubs. While the soil need not be highly enriched, it should be of good texture, mellow and easily worked. For the list of plants given below, any average soil will do, but let it be thoroughly prepared by deep spading, plowing or trenching, and work in a dressing of

well-rotted manure or compost. Never set a delicate shrub or plant in cold, heavy, unsubdued land, with the expectation of having it flourish.

To be sure many of the list given will survive even under very indifferent treatment, but the abuse of anything intended to delight the eye seems so incompatible with a desire to be surrounded by the beautiful, as to almost forbid the suggestion of possible neglect.

In this connection, we make mention of the fact that the flora of Colorado contains a wealth of ornamental plant life that is yet scarcely known, but which is destined to great popularity. Our neighbor, Mr. John Leavy, a florist of nearly twenty years' experience in Colorado, favors us with a select list of herbaceous plants, and of hardy shrubs and climbers, recommended by him for general culture in Colorado. He could extend the list considerably, but gives those that are among the most desirable.

HERBACEOUS PLANTS.

Aquilegia Cerulea—native, likes moist ground.
Delphinium Chinensis.
Perennial Phlox.
Herbaceous Pæony.
Lychnis Fulgens.
Lathyrus Latifolia (Perennial Pea.)
Dicentra Spectabilis (Bleeding Heart).
Anemone Japonica.
Lily of the Valley—moist shade.

SHRUBS THAT ARE HARDY AND DO WELL HERE.

Syringa Grandiflora.
Deutzia Scabra.
Spirea Reevesii.
Spirea von Houtii.
Spirea Collusa Rosea.
Spirea Collusa Alba.
Spirea Prunifolia.
Spirea Douglasii.
Hydrangea Paniculata Grandiflora.
Viburnum Sterilis (Snow-Ball).
Berberry—common.
Berberry—purple leaved.

CLIMBERS.

The three best vines for arbors and verandahs—Ampelopsis Quinquefolia, Clematis Ligistrum, Clematis Douglasii. All native, and perfectly hardy.

DESIRABLE PLANTS FOR PARLOR AND GARDEN.

(Colorado Agricultural College Report—Horticultural Department.)

"Nearly all varieties of ornamental plants succeed admirably outdoors. Indoors, in winter, they exhibit a luxuriance of leaf and wealth of blossom quite foreign to parlor plants at a lower altitude. Among outdoor plants, the Verbena is a great success, especially those grown from seed of approved strain. Geraniums and the different varieties of Coleus are brighter colored here, but do not grow so luxuriantly. Of Roses, all the classes succeed better here than at the East—our bright sun and command of water insuring almost a continuous succession of blossoms in the Hybrid Perpetual class, so that the name here is not so much a misnomer as in the older States. Heliotropes, Carnations, Petunias, Lantanas and most of the varieties of Asclepias are admirable for summer or winter blooming.

For flowering annuals, nothing gives greater satisfaction than the new dwarf strains of Petunia; it enjoys bright skies, and flowers abundantly until long after the first advent of frost. Not less valuable are the improved varieties of Phlox Drummondi; no garden can afford to be without them. Pansies are beautiful all summer; the native habitat of this plant is that of an open exposure, although the reverse of this is thought to be the case.

A word in closing for the Dahlia and Gladiolus. Nowhere else have I seen such a regal display of these deservedly popular flowers as in this State."

HARDY SHRUBS.

The following shrubs are in every way admirable for Colorado:

COMMON NAME.	SCIENTIFIC NAME.
Sweet Shrub	Calycanthus floridus
Button Bush	Cephalanthus occidentalis
Sweet Pepper Bush	Clethra almfolia
Bladder Senna	Colutea arborescens
Golden Bell	Forsythia viridissima
White Althea	Hibiscus syriacus
Hydrangea	Hydrangea paniculata grandiflora
Snowberry—red	Symphoriocarpus vulgaris

Snowball	Viburnum opulus
Spirea	Spiraea billiardi, and other varieties
Lilac—purple and white	Syringa vulgaris
Privert	Ligistrum amurense
Honeysuckle	Lonicera grandiflora
Mock Orange	Philadelphus coronarius
Currant	Ribes floridum
Weigelia	Weigelia rosea

ROSES.

Roses are justly classed as the most beautiful of flowers. To paint them as nature does has ever been a chief ambition of the artist. Still the perpetual question is, "who can paint the rose?" Yet these peerless bloomers are among the easiest to raise in perfection. They require a fine, rich soil and a heavy mulching of coarse litter or leaves in fall. Also considerable water in our climate, and good cultivation. Old and decayed branches and at least half of the previous season's growth should be cut away in the spring. Probably all roses, even the hardiest, do better with winter protection. It increases their vigor and makes them more productive of fine flowers. Earth is doubtless the safest and best covering for the hardier kinds. The ever-bloomers are tender and difficult to keep with us, without one has facilities for keeping them. As a rule, if these are desired, it is better to plant them each spring, and they will bloom about July. The Hybrids are much more satisfactory and quite hardy, but will kill to the roots if not protected. They are said, however, to make a new growth when killed down and to blossom the same season. We give a few of the many excellent varieties:

Hybrid Perpetuals.

Alfred Colomb, Anna de Diesbach or Glorie de Paris, Baroness Rothschild, Paul Neron, General Jacqueminot, John Hopper, La France, Mad. Plantier, Magna Charta, Prince Camille de Rohan, General Washington.

Moss Roses.

Countess de Murianais, Glory of Mosses, Luxembourg, Henry Martin, Princess Adelaide.

June Roses.

Cabbage or Hundred-Leaf, Persian Yellow, White, Sweet Briar.

Hardy Climbing Roses.

Baltimore Belle, Seven Sisters, Queen of the Prairie.

LAWN MAKING.

A beautiful lawn is always one of the most attractive features of home surroundings. It can be easily made, and with the right management a good stand of grass can be secured in a few weeks.

Where surface irrigation by flooding is to be practiced, the ground should be carefully graded so that water will run readily to all parts and be evenly distributed over the surface. It is often necessary to take off considerable of the top soil in grading, and it is better to have the excavation deep enough in the first instance to permit of easy irrigation for many years, thus making allowance for the natural filling up of the lawn from any cause, rather than be compelled to re-make the lawn in two or three years afterwards. Of course, where hose is used for watering, this precaution is not so important. After the necessary grading has been done, and the ground nicely leveled, turn on the water, not only to see that it will flow easily, but to settle the earth, so that any defect may be discovered, and remedied, in the grading. When sufficiently dried out to work, spread on a liberal quantity of well-rotted, fine manure, and spade in thoroughly.

If a large plat is to be sown, a plow may be used instead of the shovel or spade. After this is done, rake or harrow the ground smoothly and sow the seed. "Fancy mixed lawn grass" may be used, or nice clean Kentucky blue grass. with white clover.

The quantity of each required varies somewhat according to the soil. But it should be thickly sown in all cases for best results. After sowing it may be necessary to run lawn roller over the ground.

The proportion of seed used where a mixture is desired varies from three to five parts of blue grass to one of clover. Sometimes equal parts are sown. A pound of mixed seed will usually be ample for three hundred square feet of ground, and it is estimated that about five bushels would be required for an acre.

White clover makes a quick growth, and a very pretty temporary lawn.

The blue grass will take complete possession of the ground after it is thoroughly established, and with proper attention will last a long time. Cut after growth is a few inches high, and afterwards trim and water twice a week. Never let the ground bake, if possible to avoid it, when the grass is just coming up. At this time constant moisture is needed. It is better to mow often, and let the clippings remain on the lawn instead of raking them off. In this way they act as a fertilizer. The last cutting of the season may be permitted to grow sufficiently rank so that it will cover the lawn well, and thus avoid the necessity of covering with coarse manure, which is unsightly and often offensive.

SUMMARY OF INSTRUCTIONS ABOUT IRRIGATION.*

Attention is called to the importance of preparing the ground before planting, so that water can be readily run where desired. The land need not be graded to a water level, nor so that it can be entirely flooded, but should be prepared so that water will run easily. Occasional flooding is rarely desirable, and is seldom practicable except on small lots. In all cases avoid steep grades, where the soil washes badly, for the planting of fruit stock. A gentle slope, all things considered, is best, and long rows are preferable to short ones, when the slope is sufficient to carry the water easily the entire length. If the irrigation is to be done from one direction or from one side of the land, let the main lateral be made along this side, and sub-laterals be constructed down through the rows after planting is done. These are usually made with an ordinary shovel plow, and, in small gardens, with the irrigating shovel and line. For limited tracts or grounds, a neat way of conducting water is by means of a box or flume, in the place of the main lateral, with checks or gates (and both where needed) at the head of and opposite each sub-lateral, so that water can be readily turned into them and off when desired (see illustration on page 71). This plan avoids the necessity of *shoveling out* and *filling in* the dirt every time the rows are to be irrigated; the simple raising and lowering of each gate or check being all that is required. Where the land slopes in opposite directions, it is often practicable to run water both ways by means of a ditch running along the highest point. At times the lay of the ground requires a mixed system, one of sections and cross-sections in irrigating. In all such cases, the irrigator has to be governed by circumstances—in other words, to do the best he can.

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*NOTE—The suggestions following, although applicable more or less to any system of irrigation, refer more especially to the surface or furrow methods.

HOW AND WHEN TO IRRIGATE.

First of all, care should be exercised to so arrange or lay out the garden and orchard, that those things which require the least water will receive the least, and *vice versa*. In other words, don't mix everything up so in planting, that your trees or vegetables will have to be irrigated every time the small fruits are. I regard this an important precaution. Plant the cherry trees, for example, where they will get the least irrigation. Next to them the peach, pears and apples, although the latter will need considerable the first season after planting. Among small fruits, the blackberry and most varieties of grapes will get along with comparatively little water, while the strawberry, currant and gooseberry should be watered quite freely. The raspberry, if properly mulched, only needs an occasional irrigating, except when fruiting, then once a week will be about the right thing. Nearly all cuttings require plenty of moisture. For obvious reasons, no precise rule can be given for the application of water. So much depends on soil, location and the manner of cultivation, that this would be out of the question. It is safe to say that the well-established orchard would not ordinarily require more than three good irrigatings during the year. Some would do with less, but this would be about the average. The small fruits, during the fruiting season, I would water at least once a week. As to the manner of running water, I prefer a head of water just sufficient to send a moderate stream gradually along the rows. This enables the moisture to penetrate the soil more thoroughly than a rapid current would do. If practicable, water should be run on both sides of the row, without the lateral or ditch is close to one side. This is especially desirable in the case of forest or other trees on land that receives little or no cultivation. On my grounds water is usually run along several rows at the same time. Now and then soil is found that will of admit of rapid irrigation, or, as it is sometimes called, sending the water along with a rush. But this is the exception, and is often very objectionable. Of course, where water is scarce and one is limited to a certain time in its use, the best that can be done is to use it as circumstances will permit. When the water has run its course, turn it off. Don't let it soak and soak, and flood your grounds and those of your neighbor, and the streets and highways and byways.

TO RECAPITULATE.

First prepare your ground for irrigation. Avoid steep grades for fruit stock. Give preference to a gentle slope. Irrigate gradually with a mod-

erate stream. Plant those things that require least water where they will get the least. Be careful not to force your trees into a growth of wood that will not ripen before the succeeding winter. Give the small fruits plenty of water while maturing. Water the young orchard, particularly the apple trees, quite freely the first season and also the second. As a rule, withdraw the water in August from the orchard to let the season's growth mature. Don't spoil your land and crops by continuous soaking. Turn off the water (not into the street) back into the ditch when you are through with it. Water thoroughly the last thing before the ground freezes, so that your stock will go into winter quarters in good shape, prepared to resist the *drying out process* so fatal to trees in this climate.

THE RAIN BELT EXTENSION.

While this subject is somewhat foreign to the scope of this work, the author ventures to record his belief that those who maintain the position that the "rain belt" is gradually extending Westward, are making out a pretty good case. Among advocates of this doctrine are many of the thinking, practical men of the West. In Kansas and Nebraska, such men as Professors Snow, Aughey and Wilber, and Ex-Governor Furnas, and a score or more of others in contiguous States, are showing by proof that seems well nigh conclusive, a marked increase, both in atmospheric humidity and precipitation, within the past thirty years.

The thirty-eight years' record of the military post at Fort Leavenworth (covering nineteen years preceding and the same period following the occupation of that State—Kansas—by white settlers,) shows an increase from 30.96 inches, the average of the first period, to 36.21 inches, the average of second, making an average increase of 5.21 inches per annum.

The thirty years' records of Fort Reiley; of the State Agricultural College of twenty-four years; and the seventeen years' records of the State University at Lawrence—all in the same State—show an increase, respectively, of 3.05, 5.61 and 3.06 inches per annum. "Expressed in per cent." says Professor Snow, "these four stations show an increase in the last half of the period compared, as follows: Fort Leavenworth, nearly twenty-five per cent.; Fort Reiley, thirteen per cent.; Manhattan, twenty per cent.; and Lawrence over nine per cent.

These tests cover periods of time sufficiently long to justify logical conclusions, and can hardly be attributed to mere "accidental variations." They are entitled to weight. Says Mr. Hinton: "When settlement began on the line mentioned by Professor Snow, and West thereof, the annual precipitation did not exceed fourteen inches, and," he adds, "Western Nebraska to the North of Kansas, equally shows, and perhaps even in a more marked way, the peculiar Western movement of the rainfall, to which attention has been called, as characteristic of the plains division."

Professors Aughey and Wilber, of the University of Nebraska, declare that Western Nebraska and Eastern Wyoming will show a steady climatic change.

Professor Wilber says he has talked with hundreds of farmers upon the frontier, whose uniform testimony was to the effect that there was a gradual development of the resources of the soil, by the increase of moisture in its various forms, which follows upon cultivation.

More recently, Mr. Harrington, editor of the *American Meteorological Journal*, in quite an elaborate discussion of this question concludes that "increased rainfall occurs along the line of largest immigration to the plains, and as the invasion is still going on on an enormous scale, it is hardly safe to say that the attendant meteorological change will not continue farther."

Whether or not these deductions will antagonize the scientific hypothesis, that this planet of ours is gradually approaching the supposed rainless condition of the moon, or whether, even if established beyond a question, they would be regarded in the nature of "local oscillations"—that are only apparent exceptions to the hypothesis—is a matter that perhaps does not immediately concern practical people. The question is, what is actually bringing about this increase of rainfall? Probably the two main causes are, first, the subjection of a vast territory to rapid and continuous cultivation, by constant stirring of the soil and uprooting the native grasses, thus overcoming the resistence to free capillary action; and second, the extensive planting of timber and smaller growths, both of which, on a large scale, tend to increase atmospheric, as well as terrene humidity, and consequent precipitation. Another influence that may have a bearing on results is the increased humidity of Western winds, caused by evaporations from extended irrigation districts along the base of the Rocky Mountains. But whatever the true causes are, results will be of deep interest to all the country likely to be effected.

BUDDING AND GRAFTING.

SUGGESTIONS FROM MR. V. DEVINNY, OF DENVER.

Budding and grafting, in my experience, have been satisfactory, with the exception of stone fruits, which are nearly a failure. I have, however, been successful in root-grafting the peach on the plum. Owing to the dry air of our climate, some precautions are necessary to success in budding. One is, that the scion from which buds are taken should be large, not less than a quarter of an inch in diameter; to the end, that the bud, when removed, will be broad and long, a condition necessary to resist the withering effects of our climate. The bandaging should also completely cover the wound; likewise in grafting, the wound should be carefully covered. Another precaution to which I direct special attention is this, that in either budding or grafting old trees, the leading or main limbs should not be budded or grafted, but one or more of their smaller, erect branches should be selected for the purpose, and the main limb should be deadened above the grafted or budded limbs, by the removal of three or four inches in length of bark around the limb.

This strong, deadened limb will afford a good support, to which the new scions can be tied, thus preventing the disastrous effects of our hard winds. As the union of the graft and the stock is neither perfect nor strong till the stock has doubled its diameter, it is therefore easily torn away by our summer winds. For the want of this hint, I lost many large, budded limbs last summer.

Regarding the irrigation of orchards. I recommend the first summer after planting irrigation every two weeks, the second and third years the same, after which irrigation once per month will do. But no irrigation should be done after September 1st, except the first year after planting.

EFFECTS OF COLD ON FRUIT BUDS.

FROM DR. HOSKINS, OF VERMONT.

I cannot say that I have investigated the matter you ask about, but facts have forced themselves on my attention in connection therewith, and it seems very singular that so little notice has been taken of them, considering that it is so well known that peaches, apricots and many other fruits suffer from the effect of cold upon their fruit buds, either or both before and after their opening. I can only attribute the little notice the subject seems to have received, to the probability that these effects of cold upon the fruit buds of the apple have not been marked enough in Europe, or in provincial fruit-growing sections of America, to attract the attention of pomological writers. But here in the cold North it is different. We have tested here in Northeastern Vermont a good many apples, pears, plums and cherries, the trees of which belong to the "almost hardy" class, and sometimes grow to a large size, yet never bear any perfect fruit, except after an exceptionally mild winter. I have been surprised to see how many plums, cherries and Tolman, Astrachan and St. Lawrence apples, would appear on our market, not one having been offered for so long that the impression had been that the trees were all dead. After a very severe winter, even many of our "iron-clads"—Russians, Siberians and hybrids—though blooming full, will bear but a light crop. The same result follows even a moderate winter, when a sharp frost comes at blooming time. I noticed last spring that the limbs, even of Siberian hybrids or semi-crabs ("improved crabs"), which chanced to be covered with snow where it has drifted deeply, bore a full crop, although the fruit on the rest of the tree was very scattering and imperfect. A few sorts, notably Oldenburgh and Tetofsky, seem able to endure our very hardest winters and give a full crop. I notice, too, that some varieties, not quite hardy in the wood, are hardy in their fruit buds, so that, though the tree is hurt, it will bear a full crop. This, however, when it occurs, is almost invariably followed by the death of the tree, so that when we get a full crop of plums or cherries, we expect to find the trees mostly dead the next

spring. We then have to wait for young trees and sprouts to come forward, and this, too, is one reason for the long intervals between crops from this class of trees.

From the knowledge of these facts, it will not be difficult to understand why it is that there is a difference in the resisting power of the bloom of trees in flower at the same time, and all subjected to the same degree of frost. Yet—and here is a point likely to be overlooked, and which complicates the matter—trees in the same orchard, all in the same stage of forwardness as to blooming, may not be subject to the same degree of cold at the same time. After these spring frosts, it is curious to note single trees, or one side of a tree, or the upper or the lower branches, or even a single branch, having a full crop, while elsewhere there is but little fruit. I am sorry not to be able to give you more exact information, but I believe that all I really know about the matter is given above.

Yours truly,

T. H. Hoskins.

New Port, Vt., November, 1887.

CORRESPONDENCE.

Particular attention is directed to the correspondence following, from prominent fruit growers and horticulturists residing in different sections of Colorado.

Not only do these contain many valuable suggestions in regard to soil, irrigation and culture, and adaptation of varieties, but they also represent widely different localities and local conditions, and are therefore important as a guide to residents of the immediate respective divisions of the State, as well as to planters in adjoining States or Territories similarly situated.

To furnish this general information has been the aim, rather than to deal with particular localities. Every County in the State will come under some one of the grand divisions heard from, and therefore, wishing to have our book of general application, so far as possible, no special mention has been made of the already fine progress shown by such Counties as Arapahoe, Boulder, Fremont, Jefferson, El Paso, Larimer, Weld and others, nor of the almost certain large success that awaits the development of sections like La Plata County and the Montezuma Valley.

The remark is here made that native fruits that flourish in any given locality are often an important indication of what may be cultivated with profit; although this should not be construed adversely to the success of other fruits and products not so found.

FROM MESSRS. GODDING AND STEEL, OF ROCKY FORD, BENT COUNTY.

There are only two or three who have had orchard fruit trees planted long enough to bear, but with the best results. We think this is a favorite section for both fruits and vegetables, and in the future we will raise largely of all kinds.

We have two kinds of soil. That on the river bottom is a stiff adobe that is very hard to work properly, and few succeed with it, but it is very rich and durable, and a man that understands it gets splendid results. On the upland it is of a light-gray color and is mixed with con-

siderable sand. In this soil fruits and vegetables grow to perfection. It is easily broken up and yields a fine crop the first season.

Water-melons yield from 1,000 to 1,500 melons per acre, and all small fruits and vegetables do equally well.

FROM PRESIDENT C. S. FAUROT, OF THE NORTHERN COLORADO HORTICULTURAL SOCIETY, BOULDER COUNTY.

I am very glad to hear that you are writing a book on the subject named in your letter.

I am trying several new varieties of blackberries, but none have fruited except the Ancient Briton, and I think that is one of the most prolific bearers I ever saw.

In regard to the irrigation of fruits, I don't know that I can add anything new, but I will say this: I would recommend a heavy, clay soil for strawberries and a limited use of water, as I think too much water has a tendency to make the fruit soft and insipid in taste. Ground that currants are grown upon should be kept moist, not wet.

Raspberries and blackberries should be watered once a week through the fruiting season; after the fruit is gone, give but little water, in order that the wood may ripen for winter. Grapes, if grown on heavy soil will not need more than two or three irrigations a year, but if on light soil, I should recommend at least five or six irrigations—one, say, as they are in bloom, and two or three after that, as the ground may require.

In regard to the varieties grown here, I will give you a few of the leading ones: Strawberries—*Manchester*, *Jucunda*, *Wilson*, *James Vick*, *Captain Jack*, Crescent and Sharpless. Raspberries—Cuthbert, Turner, *Hansell*, Herstine, *Souhegan*, *Gregg*, Mammoth Cluster. Blackberries—*Ancient Briton*, Early Cluster, Snyder, Wilson, *Kittatinny* and Lawton.

The varieties in *italic* I consider good.

Of grapes I will give just those I could recommend for cultivation: Concord, Hartford, Worden, Moore's Early, Champion, Wilder, Delaware, Salem, Brighton, Massasoit, Lindley, Lady, Martha, Empire State, Chasselas. These will do to tie to.

Currants—Red Dutch, Red Cherry, White Dutch, White Grape, Black Naples. Gooseberries—I cannot say anything for them.*

* NOTE—Mr. Faurot, being almost exclusively a grower of small fruits, does not refer to the larger fruits, like the apple, pear and plum. All of which do exceedingly well in Boulder County. Our general list of these will be found well adapted to culture in that County.

FROM HON. S. A. WADE, OF DELTA COUNTY.

Under date of August 14, and October 31, 1887.

As you are aware the Ute Indians were not dispossessed of this country until September 1st, 1881. Therefore all our progress in the development of the fruit interest in this country cannot date back earlier than the spring of 1882.

The list of native or wild fruits is short, consisting of the following: Buffalo berries, two varieties, red and yellow. These fruits grow very luxuriantly upon our river and creek bottom lands at an altitude of 4,000 to 6,000 feet. The fruit resembling the currant, growing on scrubby trees from eight to twelve feet in hight. Very prolific and a sure bearer. Are improved by cultivation. Ripen about August 15th.

The service, or Juneberry, grows on the hills at an altitude of 4,000 to 8,000 feet; fruits best when protected from the wind and sun; is dwarf, six to ten feet; fruit large and fine.

The wild cherry is dwarf; frequently plants two feet high are full of fruit; grow best from 6,000 to 7,000 feet altitude, where they are quite prolific.

The red raspberry of the mountains is found upon the Grand Mesa at an altitude of 7,000 to 9,000 feet, where the snow falls three to six feet in winter; are very prolific in their mountain home, but do no good in the valleys with the best of care. They must have their snowy covering.

The black currant found on some of the streams in abundance; bush six feet high; prolific; fruit large and good.

Strawberries grow 7,000 to 9,000 feet quite plentiful; some of these wild varieties are fair size.

Of our cultivated fruits this is but our sixth year, so we can but report the progress after close, careful watching this growing interest. Myself being one of the pioneers of the fruit interest in this part of the State, I will say, that in the spring of 1882 I brought here from Illinois and Missouri quite a collection of fruits of different kinds, all one year old; put them out first year in nursery and re-transplanted them in the spring of 1883 into orchard, and now I have peach and apricot trees measuring eighteen inches in circumference around the trunks or bodies; cherry trees fifteen to sixteen and one-half inches; apple trees twelve to thirteen inches, with large, fine heads as ever grew, I think.

I have thirty-one varieties in orchard; over fifty varieties of apples

for trial, many of which are now in bearing; have no reason to condemn or even to complain of any variety yet; all perfectly healthy and no winter killing, codling moth, borer or any other insect or pest. Pears have done fairly well, having on my grounds five varieties, and not a blighted leaf on any of my fruits.

I sold my blackberries this season at fifteen cents per quart, and the yield brought me fully $400 per acre.

I have ten varieties of cherries, same number of plums, and about the same of apricots and peaches. All my apricots are Russian except one variety.

The Morello family of cherries are as hardy as the oak. All our small fruits have done remarkably well this season, and my grapes are a wonder to behold, six-year-old vines having one hundred and fifty pounds of fruit on. I have some sixteen varieties in bearing; my first in favor is the Niagara; next choice is hard to make among the following: Rogers' No. 1 and 9, Janesville, Catawba, or Telegraph, and two other unnamed varieties. The Clinton is a wonderful bearer here. The Salem (No. 22) is a good bearer, good grower and a good grape, but it drops from the bloom so as to make bunches open and loose.

I am now trying a few California varieties with good prospects.

We have a favored spot here for fruit growing, no doubt the best in the State. Our altitude is 5,500 feet above the sea level.

I have seen growing at an altitude of 7,800 feet the following fruits: Duchess apples, Whitney, Transcendant and Siberian crabs. I saw these fruits last week. The trees were very full of fruit, but the fruit was small, especially the Duchess apple, which were not larger than crabs.

We have quite an extent of country in this part of the State that ranges from 6,000 to 8,000 feet altitude, that in time will be utilized for fruit growing quite extensively in the near future, especially for small fruits. It is high table-land with a good deal of timber and grasses, where the snow falls about three feet in winter and rains often during the summer season, with a climate much like a portion of Michigan.

There is one thing I can note as very peculiar in the fruit trees on this Western or Pacific Slope: Our trees may make a wonderful growth of wood during the summer and will bud profusely at the same time, and if a late frost should happen to come in April or early in May (which we have never had) and kill off our grape crop, by giving the vineyard a thorough irrigation for about three days the vines will re-set and make a

fair crop; in fact we have to guard against this second growth continuously throughout the fruiting season.

It is very difficult for you to overestimate the natural fruit advantages of this part af the State.

In letter of October 31st, he says:

I have two distinct classes of soil on my farm. The first bottom land is sandy loam, with four to six feet of clay sub-soil. This is my best grape, peach and small fruit lands, which I irrigate from three to six times during the growing season, except strawberries, which I keep quite moist. I irrigate no fruit on this land, except the strawberries, after September 1st. We usually get rains in the fall sufficient for all fruits.

My second bottom land is of the black loam, with quite a mixture of the adobe. This land is strong and deep soil. I consider it my best apple and pear land. I have twenty-five acres in this fruit on this land.

I raise corn, potatoes and vines among my trees, and only irrigate sufficient to promote a good, healthy growth to my corn, and find it about right for my trees. I turn on the water about once a week for a day and night, as a general thing, through the season, and our corn matures about September 1st to 10th, when I shut off all irrigation water. After that our fall rains take care of the fruits, and they ripen their wood in excellent shape for the winter. We lay nothing down for winter except the tender California grapes.

Peaches and apricots begin bearing the second year after budding. Many varieties of apples bear at three and four years from graft. Especially is this the case with the Russians. Many of the Americans bear at four and five years. Cherries and plums bear very early with us. It is is not unfrequent to see a two-year-old cherry tree full of fruit.

My choice of fruits for profit here is the grape. The of yield my five-year-old vines this year was enormous.

FROM GEN. R. A. CAMERON, CANON CITY, FREMONT COUNTY.

At Canon City the water of the Arkansas does not seem to be impregnated with much mineral matter, which, like rivers, notably the Rio Grande in New Mexico, enriches the soil. On the South side of the river, where the soil is composed chiefly of decomposed red and white sandstone, irrigation practiced once or even twice a week in the warm and dry seasons seems to act like so much refreshing rain. On the North side of the river, however, where the soil is composed largely of decomposed

shale and lime rock, a rich and heavy adobe, irrigation has to be practiced with great care, and is best conducted in the evening or on cloudy days, which prevents the scalding of trees. A good soaking once in three weeks is beneficial and acceptable to trees, bushes and vines, as well as to vegetables. Some of the latter, however, requiring water oftener.

While some, or a large variety of grapes, such as the Elvira and Salem, bear irrigation well, the Concord, Pocklington, and others of the Labrusca family, do not relish much water. Whether it is the water itself, or the "alkali" it develops and brings to the surface, I do not know. So strongly has this dislike of irrigation impressed many in regard to the Concord, that Dr. Craven, a leading horticulturist here, only waters his Concord vines in the spring and fall, and yet he has luxuriant crops of most excellent grapes.*

FROM EX-PRESIDENT J. S. MC CLELLAND, OF THE NORTHERN COLORADO HORTICULTURAL SOCIETY, LARIMER COUNTY.

I use a great deal of water during the fruiting season. Water strawberries after each picking, and never allow them to get dry. Newly-planted trees I never allow to get dry. My oldest orchards I have not irrigated this year, but will do so this month (October).†

The best fruits? Well, here they are:

Apples—Summer—Oldenburg, Tetofsky, Red June, Fall, Wealthy and Famous. *Winter*—Ben Davis, Willow Twig and Golden Russet.

Plums—Miner and Weaver. The Miner is a glorious plum, and remarkably hardy. Beats everything else with me.

Grapes—Concord, Worden, Champion and Sweet Water, especially the latter, do best with me. Am going to make a success of grapes.

Gooseberries—Houghton.

Currants—White Grape, Cherry and Red Dutch.

Strawberries—Crescent, Manchester and Chas. Downing.

Blackberries—Wilson and Snyder.

Raspberries—Red—Turner and Cuthbert. *Black*—Mammoth Cluster and Gregg.

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*NOTE—*Fremont County* is one of the pioneer fruit growing Counties of Colorado. The oldest commercial orchard of the State, that of Jesse Frazier, is located here, which in 1886 yielded 10,000 bushels of apples.

† NOTE.—Mr. McClelland's soil is a clayey loam.

FROM REV. S. W. DE BUSK, OF LAS ANIMAS COUNTY.

In the last volume of our State Horticultural Report you will find an article entitled "The Beginnings in Las Animas County," which gives a correct statement of our first efforts in this County. My own orchard the past season (1887) yielded eighty bushels of Ben Davis, Rawles Janet, Wine Sap, Missouri Pippin, Tetofsky, Duchess, Cooper's Early White, Fall Spitzenburg, Wealthy and Hyslop. Crabs did well with me this year. My first trees were set in the year 1881. Large holes were dug, and a heap of bones placed in each hole. Trees set a rod apart, I find, will prove to be too close soon. The limbs of the Ben Davis trees promise to touch across the space between the rows in three years longer.

One Missouri Pippin tree, set three years ago last April, ripened one hundred apples five years from graft. One Jonathan tree, same age ripened eighty apples; one Ben Davis tree, same age, ripened seventy-five apples remarkable for fine size and color. So much for early bearing.

My trees are on a hill-side, sloping to the North. Soil, a clay loam, which is usual on our prairies. At two points leads of slate crop out on knolls. This upland needs irrigating twice as often as the compact loam or adobe of my low bottom.

In starting my trees, six years ago, the land was kept in hoed crop; part being used for the vegetable garden, and the other part cultivated in beans, turnips, and sometimes corn.

The spots irrigated oftenest gave best results. Where the cabbage and tomato patch was, and the water ran three to five times a week, trees grew most rapidly, bore earliest, and to-day are the favorites in the orchard. My hill-side was rough, having two or three gullies across it, when I began to cultivate it. In irrigating this uneven land, a few trees, which stood in low places, received twice the water the others had. Those getting a superabundance of water on this well-drained soil are, in every way, the best trees. It is well understood, here in my family, that on this hill-side of clay loam, underlaid by slate, there is no danger of irrigating too much for apples, pears, raspberries, strawberries, currants and gooseberries, even if that irrigation be twice a week from June 1st to September 1st, seasons of heavy rains excepted, of course.

The above is the sum of my experience for five years.

The past summer, matters were quite different with me. The floods

of June practically destroyed my irrigating ditch. This hill-side orchard, having been well irrigated once in May, was exposed to the fierce heat of July and August without irrigation. The half and one-third grown apples ceased to grow, and began to shrivel up on the trees. Water was obtained to give all a good soaking once late in August. The trees revived in a few days. The fruit resumed its growth, and, with few exceptions, matured well, though later than usual. Had not the trees been well established they must have died.

Another incident on this well-drained upland, which requires frequent irrigation, teaches me that trees might succeed almost without irrigation, and I will give this for the benefit of the rain-belt farmers, some hundred of whom we have in Eastern Las Animas County.

In my early experience, I made the mistake of setting largely of the Transcendant crab, a variety which is nearly useless to me, because the buds push out early in the spring, and have four years in succession been nipped by frost.

To test to my satisfaction the theory of mulching to make a tree bloom late, I placed a wagon load of old, thoroughly-rotted manure about the roots of three large crab trees, leaving other trees unmulched. The mulch was applied when the ground was frozen and some snow was on. The mulch utterly failed to retard the blooming. It did seem to me the mulched trees bloomed earlier than the others. The manure used for mulch could not have heated, for it had lain out-doors two years, some of it even longer, before being used. But when the trees were exposed to a torrid summer, without any irrigation, those mulched flourished with surprising vigor. I strongly suspect, now, if one could spare a heavy wagon-load of such mulch to each tree, that our rain and snow fall might give sufficient moisture for good results.

Many ask me, how often to irrigate? So much depends upon the soil, location, drainage, etc., that I can give no rule. Have often said this, that a corn field will always indicate, to the experienced farmer, when water should be applied; and likewise, an orchard, young or old, will make its wants known to the horticulturist who is attentive and quick to comprehend the language of his trees. My trees young, or old, plead piteously for water when they grow too dry.

Of course, I leave off irrigation in the fall—usually September 15th here—to allow the wood to mature for winter.

HORTICULTURE IN MONTROSE AND OURAY COUNTIES.

By A. D. Fairbanks, Montrose.

Among the first to plant fruit trees and small fruits in Montrose County were the following named persons: Gustavus Frost, Ross Brothers, Young Brothers, Eldridge Brothers, David Markley, O. D. Loutsenheizer. Among the first to plant fruit trees and small fruits in Ouray County were the following named persons: R. H. Higgins, J. Smith and Preston Hotchkiss.

From four to five years is the extent of time in which fruit of any kind has been cultivated in either of the above Counties, with possibly one exception. R. H. Higgins, who located nine or ten years ago within four miles of Ouray City, and has, for nearly the entire time, grown small fruits of some kinds with marvelous success. The hardy varieties of raspberries and blackberries he has propagated successfully, and both have fruited heavily each year. Currants and gooseberries have also thriven well with him, as have also strawberries. He is located at an altitude of 7,000 feet.

Apples, cherries, plums and pears are not grown very extensively in Ouray County.

At an altitude of 6,000 feet, near Montrose, a few families have planted trees with varying results. A Mr. Smith has raised apples and pears, also grapes, at an altitude of 6,000 feet and more, and on the river bottom, Preston Hotchkiss, two miles below, on the Uncompahgre, has a fine start in all varieties of fruit that can be grown in the best parts of the East. The showing, for this time, is wonderful in the growth, vigorous appearance, and all that portends to fruit culture.

The soil is of a dark brown color naturally, and by cultivation turns to a black, loamy appearance.

The Eldridge Brothers, still lower down the river and in Montrose County, have succeeded commendably.

O. D. Loutsenheizer, half a mile East of the town of Montrose, and on what may be called a genuine adobe ranch, has, after several fruitless trials on a large scale, succeeded in a small way in fruit raising.

All small fruits do well on this adobe, and apples, pears, apricots and plums thrive better on this kind of soil, when it is properly managed, than on the river bottom, as the latter, after two or three years, proves too

wet for the roots which have penetrated the earth downwards, in that time three or four feet.

Mr. Loutsenheizer is very enthusiastic over fruit culture in this valley, especially on the adobe.

The Ross Brothers, Young Brothers and Gus Frost have severally demonstrated that all moderately hardy varieties of apples, plums, pears and even peaches at an altitude of 5,500 feet can be successfully grown. The quality of fruit in this valley is remarkable. Demonstration has settled grape culture, and small fruits of all kinds and varieties; and we are sure that anything that can be grown in the Middle States can be grown here.

Thus far all kinds of fruit have been very free from insects or any of those afflictions so common in the East.

The greatest extremes in Montrose County, on an average of five years, is from fifteen degrees below zero to ninety degrees above.

The character of the soil is variable. There is adobe, red gravelly soil underlaid from three to five feet below the surface with a solid cement of pebbles and clay, or some similar formation, perhaps by an admixture with the soil of a sufficient amount of gypsum.

Irrigation soon softens this underlying stratum and renders this kind of land, which is confined mostly to the mesas, very receptive, and thus seepage is very rapid and the necessity of irrigation more frequent than on the river bottom, where the soil is constantly under-moistened by seepage from the river.

The adobe, which is generally the second bottom, and is in depth from ten to thirty feet, when once well soaked with water to the depth of from eighteen inches to two feet, is sufficiently irrigated, as a rule, by two or three times in a season for small grains; while the mesa soil as a rule needs water every two weeks, in some localities oftener. If small grains are planted near the surface in the adobe ground it will need water often, as the hot sun bakes rapidly the top of the ground in the summer months. If there is any favor to special varieties, there has not been sufficient time to demonstrate it in Montrose County.

ROUTT, ROUTT COUNTY, COLO., November 8th, 1887.

Looking towards fruit culture in this part of the State, the part that I shall describe is but a small part of the great County in which I live. One man I believe planted out a few trees last spring on the river bottom,

and I believe they did very well until they were eaten up by the cattle.

Judging from the altitudes by Hayden and his geological survey, our best farming lands have an altitude of from 6,300 to 6,500 feet above the sea.

The sage land is the best, and is a deep, sandy loam, and very rich, and where the sage gets a sufficiency of water it grows to a great size, and often reaches the hight of six or seven feet. The grease-wood lands are adobe, and are not considered good farming lands.

There are but few kinds of native fruit growing in this vicinity —the choke-cherry, sarvis berry, mountain raspberry and currant. I have seen cherries that grew at an altitude of 7,000 feet that were both large and well flavored.

The mercury was not lower than twenty below zero last winter, and not very long spells of cold weather at any one time, and not higher than one hundred during the hottest day of summer.

I can give you a better idea of what will succeed by giving you a few facts of my own personal experience in my vegetable garden. Sweet corn matured so as to make good seed; also beans. I planted out a few tomato plants the first of July that ripened a few tomatoes. My water-melons did not succeed for lack of irrigation during the Indian troubles, when we had to leave our homes and seek safety in forting up our place. Our place is only a half-mile north of the trail taken by the Indians at the time the Meeker women were taken into captivity.

The hills that have timber on are very poor and rocky, producing but low, scrubby cedar, that seldom if ever gets long enough for two fence posts. The canons in the mountains, and sometimes nearly to the tops of the mountains, are covered with scrub oak and quaking asp, some box elder and pinon pine.

The general lay of the country is very hilly and uneven and cut up with gullies and wash-outs, so that travel on horseback is sometimes difficult. The gullies and wash-outs would indicate heavy rains, and yet I have not seen anyone that has seen a hard rain since the country has been settled. Several persons here, at Axial, and at Yampa, have been getting fruit trees

I should be much pleased to see a more general desire to improve the country by setting and growing fruits of such kinds as would succeed, and I think many kinds would do well here. Only eighty miles to the West of us, down at Ashley, I am told they raise considerable fruit.

And with money and energy I think this would become a fruit-growing country. ELISHA BENNETT.

APPLES FOR WELD COUNTY.

BY O. H. GALLUP, ESQ., GREELEY, COLORADO.

The Wealthy, Gideon, and Excelsior of the Minnesota kinds have fruited on my place, but with me the Wealthy lacks in hardiness a little and is a shy bearer; the Excelsior is also slow to fruit. I have trees that are of good size, but have never had but three or four apples form thereon. The Gideon bears early and abundantly and is "A No. 1."

The Russian Yellow Transparent is the only foreign apple I have fruited, and I think the best apple on my grounds.

The Oldenburg seems to be hardy and productive. Gideon's Florence (crab) will fruit the earliest and fullest and dodge the late spring frosts better than any other apple I have, and for cooking, it almost equals a good standard. I have growing, but not fruiting yet, Mann, and the Haas, that are promising trees. I find that trees on crab roots stand much better than those grafted on common stock.

As to soil best adapted for apples, my trees here in town are on a stony soil; on my old farm it is a coarse, sandy soil; on my West farm the soil is finer sand, with a little adobe added, and on this the trees seem to do best in their growth, and also fruit more freely.

As to frequency of irrigating, this will depend on the soil, but I am inclined to the opinion that after trees are well established, (say after the first year,) they need less water than we have been in the habit of giving them. A good, thorough wetting about once a month I think about right for established trees.

MISCELLANEOUS.

NUMBER OF SEEDS TO THE POUND, BY ACTUAL COUNT.

Forest Trees.

COMMON NAME.	BOTANICAL NAME.	NO. IN POUND.
White Birch	Betula Alba	500,000
American Mountain Ash	Pyrus Americana	108,327
American White Elm	Ulmus Americana	92,352
Red Elm	Ulmus Fulva	54,359
Black Locust	Robinia Pseudacacia	28,992
Green Ash	Fraxinus Viridis	22,656
Scarlet Maple	Acer Rubra	22,464
White Pine	Pinus Strobus	20,540
Ailanthus	Ailanthus Glandulosa	20,161
Hardy Catalpa	Catalpa Speciosa	19,776
Box Elder	Acer Negundo	14,784
Silver Fir	Abies Pectinala	12,000
Osage Orange	Maculara Aurantiaca	10,656
American White Ash	Fraxinus Americana	9,858
Rock Elm	Ulmus Racemosa	8,352
Red Cedar	Juniperus Virginiana	8,321
Berberry	Berberis Canadensis	8,183
Sugar Maple	Acer Saccharinum	7,488
Norway Maple	Acer Platanoides	7,231
American Basswood	Tilia Americana	6,337
Black Ash	Fraxinus Sambucifolia	5,629
Black Cherry	Prunus Serotina	4,311
Honey Locust	Gledilschia Friacanthos	2,496
Silver Leaf Maple	Acer Dascycarpum	2,421
American Sweet Chestnut	Castanea Vesca	90
Hickory (Shell Bark)	Carya Alba	78
American Horse Chestnut	Æsculus Glabra	36
Black Walnut	Juglaus Nigra	25
Butternut	Juglaus Cinerea	15

Fruit Trees.

	About
Apple	12,000
Cherry Pits	1,000
Peach	200
Pear	15,000
Plum	600
Quince	15,000
Mulberry (fruit bearing)	200,000

VEGETABLE AND GRASS SEED TABLE.

(From Henry Lee's Catalogue.)

AVERAGE QUANTITY OF SEED SOWN TO AN ACRE.

IN DRILLS.

Dwarf Beans	75 to 90 lbs
Early Peas	75 to 90 lbs
Marrowfat Peas	70 to 80 lbs
Beets	4 to 5 lbs
Mangel-Wurzel	6 to 8 lbs
Carrots	2 to 3 lbs
Onions	4 to 5 lbs
Onions for sets	20 to 30 lbs
Onion sets	300 to 350 lbs
Parsnip	4 to 5 lbs
Radish	6 to 8 lbs
Rutabaga	1 to 1½ lbs
Spinach	10 to 12 lbs
Salsify	10 to 12 lbs
Turnips	1 to 1½ lbs
Tomatoes to transplant	¼ lb

IN HILLS.

Corn	8 to 10 lbs
Cucumbers	1 to 1½ lbs
Musk-Melon	2 to 3 lbs
Water-Melon	3 to 4 lbs
Pumpkins	2 to 3 lbs
Squash	2 to 3 lbs

QUANTITY OF SEEDS REQUIRED FOR A GIVEN NUMBER OF PLANTS.

Asparagus	1 oz to 500 plants
Cabbage	1 oz to 2,000 plants
Cauliflower	1 oz to 2,000 plants
Celery	1 oz to 3,000 plants
Leek	1 oz to 1,500 plants
Endive	1 oz to 3,000 plants
Egg Plant	1 oz to 1,000 plants
Lettuce	1 oz to 3,000 plants
Pepper	1 oz to 1,000 plants
Tomato	1 oz to 1,500 plants
Thyme	1 oz to 5,000 plants
Tobacco	1 oz to 5,000 plants
Sage	1 oz to 1,500 plants
Savory	1 oz to 2,000 plants
Marjoram	1 oz to 1,500 plants
Rhubarb	1 oz to 500 plants

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